

FT
MEADE

4HE
1055
Copy 1



UNION PACIFIC RAILROAD.

3 = APR 22
Copy _____ 1958

REPORT

OF THE

CONSULTING ENGINEER

ON THE LOCATION AND CONSTRUCTION OF A

BRIDGE ACROSS THE MISSOURI RIVER.

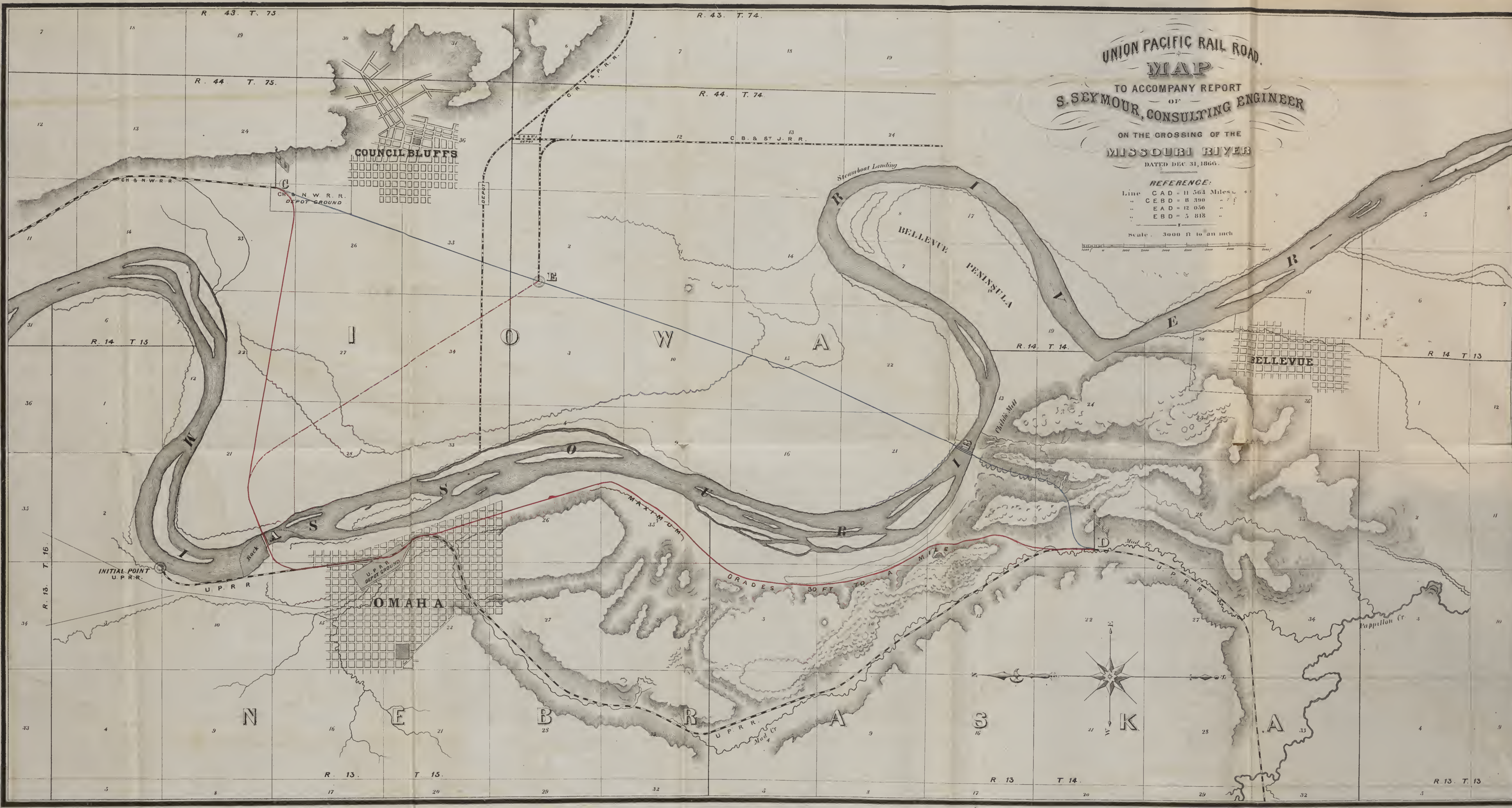
Dated December 31, 1866.

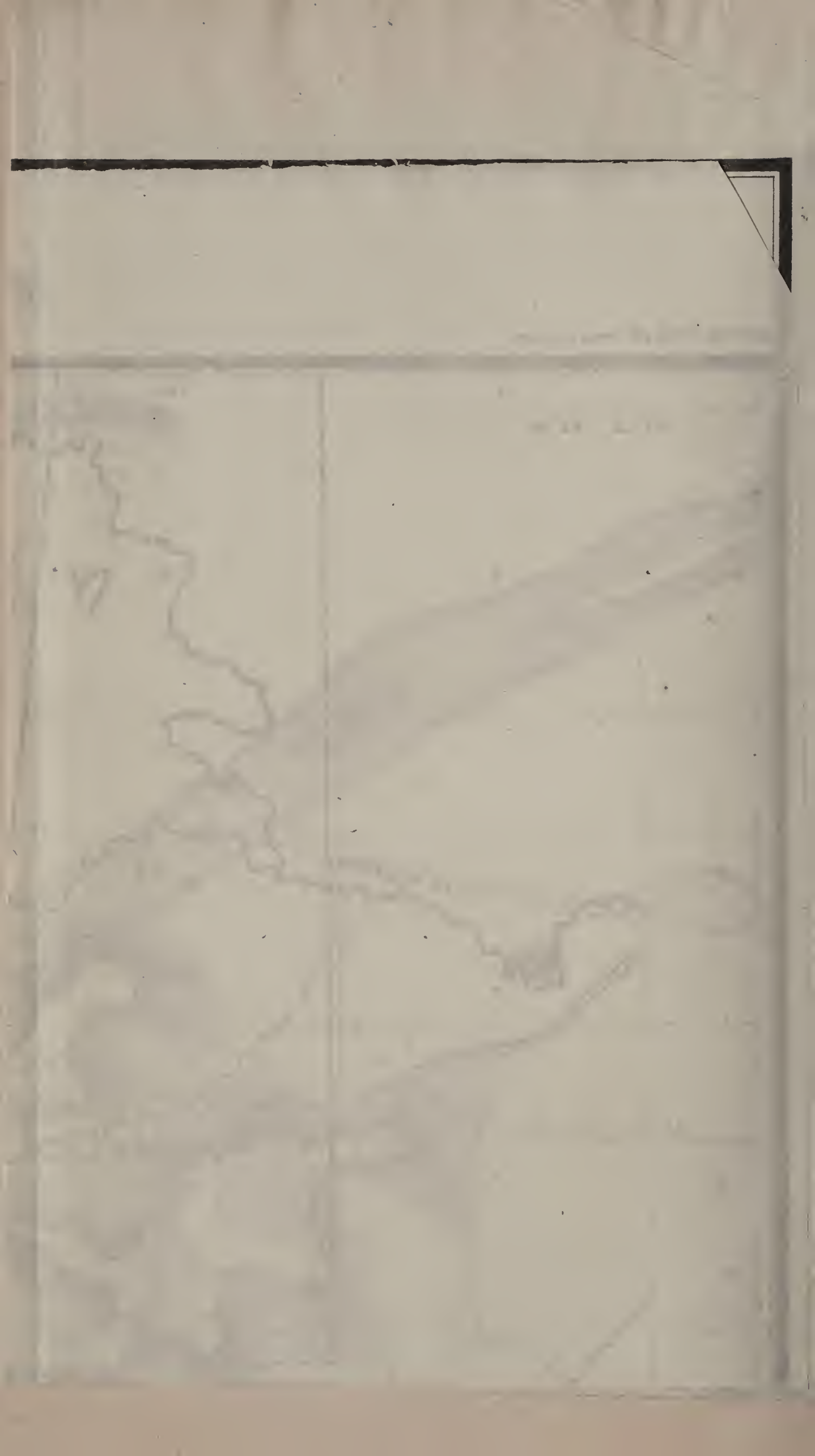
New York:

D. VAN NOSTRAND, No. 192 BROADWAY.

1866.







UNION PACIFIC RAILROAD.

REPORT

OF THE

CONSULTING ENGINEER

ON THE LOCATION AND CONSTRUCTION OF A

BRIDGE ACROSS THE MISSOURI RIVER.

Dated December 31, 1866.

New York:

D. VAN NOSTRAND, No. 192 BROADWAY.

1867.

4-HE

1055

UNION PACIFIC RAILROAD.

Engineer Department,

No. 20 NASSAU STREET,

NEW YORK, *December 31, 1866.*

SIR :—

I have the honor to acknowledge the receipt of your letter of the 6th inst., in which you inform me that “It is in contemplation to build a bridge across the Missouri river at Omaha, to accommodate the traffic of the Union Pacific Railroad,” and ask me to give you my “views as to its location and proper mode of construction, and submit them so that they may be laid before the Board of Directors at their next meeting.”

In obedience to your request I beg leave to submit the following :

R E P O R T

On the location and construction of a Bridge across the Missouri river, at the eastern terminus of the Union Pacific Railroad.

I.—IMPORTANCE OF THE SUBJECT.

The question of bridging the Missouri river at the present time, is one which involves many considerations of great importance, not only to the Union Pacific Railroad, but also to the various railroads which are, sooner or later, to connect with it at or near its eastern terminus ; and it should therefore be considered with reference, both to its present and future relations to the interests of all parties concerned.

II.—PRESENT ASPECT OF THE CASE.

When viewed in its present aspect, we find that the Union Pacific Railroad is completed and in operation a distance of three hundred and five miles westward from the Missouri river; and that about thirteen hundred miles of road yet remain to be constructed. Its principal business is the transportation of the materials and supplies required for its construction; and this will probably be the case during the next five years, or until the road is completed.

The initial, or eastern terminal point, has been fixed under the law, by the President of the United States, at a point more than two miles above the present depot grounds and buildings at Omaha, without any apparent regard to the engineering or commercial considerations involved, either in crossing the river eastward, or constructing the road westward.

The line, as now constructed, has a grade of sixty-six feet per mile, ascending westerly, a distance of three miles from the depot grounds at Omaha; which grade the Company propose shall be reduced to a maximum of thirty feet per mile whenever the business of the road shall render it advisable to make the change. The line upon which it is supposed that a maximum grade of thirty feet per mile can be most easily and economically obtained, leaves the present track at the Omaha depot, follows the full red line on the accompanying map, and unites with it again in the Valley of Mud Creek, at a distance of about eight miles from Omaha. Between this point of intersection and the initial point above Omaha, the Company has expended, upon the line now in operation, about \$1,250,000, in the purchase of real estate, construction of the road, and the erection of machine shops, engine houses, saw-mills, burnetizing works, &c., &c.

Upon the opposite side of the river we find that the grading of the Iowa division of the Chicago and Northwestern Railroad is completed to the east bank of the Missouri, at a point almost directly opposite your own depot grounds; and that the Company have secured depot grounds for, and are actually constructing the western terminal station of their

road, upon the table lands about two miles east of the terminus of their track at the river. This Company, I am informed, has entered into a contract with your Company, by the terms of which their road is to be completed and in operation to the Missouri river on or before the first of April next.

The Chicago Rock Island and Pacific Railroad has been located to enter the Valley of the Missouri, at the mouth of the Valley of Mosquito Creek; and its depot grounds and river connection are located nearly two miles farther south than those of the C. & N. W. R. R. This road will probably be completed within the next two or three years.

The Council Bluffs and St. Joseph Railroad is located to, and its northerly terminal station established at, a point still further south. The track of this road is now being laid from Council Bluffs southward; and it will probably be completed to St. Joseph during the coming year.

The Burlington and Missouri River Railroad is also in process of construction, but with what dispatch I am not advised. It is presumed, however, that it will be completed to the Missouri river long before the completion of the Union Pacific Railroad. The track of this road will probably intersect the Council Bluffs and St. Joseph Railroad at some point opposite the mouth of the Platte Valley, from ten to fifteen miles south of Council Bluffs.

It is also proper to mention, in this connection, the following branches of your road, which are contemplated by the law, some of which are now under construction.

The Sioux City branch will, in all probability, be constructed within the next five years, either to an intersection with the Chicago and Northwestern Railroad at the mouth of Boyer Valley, or to an intersection with the main line of your road, either at Fremont, North Bend, or Columbus.

The Atchinson branch is now completed a distance of sixty miles from the Missouri river; and will probably be extended to the main line of your road, either at Fort Kearney, or the one hundredth meridian, within the next five years.

The Kansas branch is now completed a distance of one

hundred and fifty-five miles westward ; and will probably be extended as far west as the meridian of Denver, during the next three or four years.

III.—FIVE YEARS HENCE.

Looking forward, then, to a period of time five years hence, we may expect to see the main line of the Union Pacific Railroad, and all its eastern branches and connections, fully completed and in successful operation. We may also expect to see these branches and connections struggling and competing with each other for the traffic which goes to, and comes from, the Pacific Ocean and intermediate points, over the main line of the Union Pacific Railroad.

The great rival cities of Chicago and St. Louis will also be engaged in the strife, aiding and encouraging, by every means in their power, the diversion of this traffic to such of the branches and connections as may lead in their respective directions.

Then we shall also see, just what we have all seen or heard of in similar cases during the past ten or twenty years, these rival companies engaged in improving their routes, shortening their lines, and reducing their grades, in order to enable them to compete more successfully with each other.

Many millions of dollars have already been spent by the New York Central, the New York and Erie, the Pennsylvania Central, and other roads ; and many more millions will yet be spent upon the great competing railroad lines already constructed in this country, for the purpose of correcting the mistakes of ignorant or unreflecting Directors, and incompetent Engineers.

IV.—TEN YEARS HENCE.

At the expiration of ten years, it is assumed, that other great through lines of railroad may be competing with the Union Pacific Railroad itself, for the traffic of the world across our continent.

The Northern Pacific, and the Southern Pacific, with their

respective branches and satellites, are all down on the financial and political slates, to be completed within the next ten years. And, even if not then completed, it is to be feared that scheming financiers and politicians will so far succeed in involving the General Government in their construction, that it will become either paralyzed in its efforts to aid your road to the extent of its present obligations ; or be bound, in self-protection, to carry out and complete such others as may in this manner become saddled upon it.

Then your Company, as well as your Eastern connections, will see and feel the great and vital importance of having secured the very best location for your road, with reference to alignment and grades, of which the difficult and mountainous country, through which it is compelled to pass, will admit. Not merely from Omaha, or the initial point westward (for all points as well as personal and local interests will then have lost much, if not all, of their present individuality and importance), but all the way from New York and Chicago to San Francisco, and all the way from New York and St. Louis to San Francisco. Otherwise you might find too late, that the trade and travel were being diverted from your road, either by way of Puget Sound to Quebec or Portland on the north ; or by way of San Diego, or the Gulf of California, to Galveston, New Orleans, Charleston, or Norfolk on the south.

It may be said, and perhaps truly, that, when this time arrives, there will be enough business for all these roads ; but experience and observation have taught me, that no assumption of this kind will justify a railroad company in departing very widely from sound engineering principles, and the established laws of trade and commerce.

V.—COMPARISON OF LINES PROPOSED.

Having thus stated, as briefly as possible, some of the leading facts and principles which should, as they undoubtedly will, have their just and proper weight with the Directors, I will proceed to a more critical examination of the question under consideration.

The Chief Engineer, General G. M. Dodge, has submitted to

this office a very intelligent report upon the subject, accompanied by maps, profiles, estimates, cross-sections, and soundings of the river. The map accompanying this report is reduced from the larger map submitted by the Chief Engineer, with some slight and unimportant changes in the position and designation of the two principal competing lines, reported upon by him, for the bridge. And the estimates of the Chief Engineer are assumed to be correct for the respective plans and locations proposed by him.

By referring to the map it will be seen that the upper crossing, marked A, is located just above the masts of the telegraph lines, where they cross the Missouri river; and that the lower crossing, marked B, is located just above the Bellevue peninsula, near a point known as Childs' Mills. This lower crossing is about six and a half miles below, or south of the upper crossing at A.

The full red line drawn on the map from point C, or the present depot grounds of the Chicago and Northwestern Railroad, crossing the river at A, passing through the Union Pacific depot grounds at Omaha, and following the line adapted to a maximum grade of thirty feet per mile to an intersection with the present track, and thence along this track to a point marked D, is 11.564 miles in length.

The full blue line drawn on the map from point C, passing through point E, which is assumed as the natural focal point of all the railroads terminating on the east side of the river, in case the crossing at B is adopted, and of all but the Chicago and Northwestern in case the crossing at A is adopted; thence crossing the river at B, and intersecting the present track of the Union Pacific Railroad at D, is 8.390 miles in length; or 3.174 miles shorter than the full red line.

It will be observed that the above comparison of distances affects only the business connections between the Union Pacific, and the Chicago and Northwestern Railroads.

The following comparison between the focal point E, and the junction of the red and blue lines at D, affects the business connections of all the other roads terminating on the opposite, or east side of the river.

From point E, following the broken red line to its inter-

section with the full red line east of the bridge crossing at A, and thence following the full red line westerly to its junction with the blue line at D, the distance is 12.056 miles.

From the same point E, following the full blue line across the river at B, to an intersection with the red line at D, the distance is 5.818 miles ; or 6.238 miles shorter than the broken and full red lines.

The following would perhaps be a more mathematical statement of the length of the different lines :—

Line C, A, D,	=	11,564 miles.
“ C, E, B, D,	=	8,390 “
“ E, A, D,	=	12,056 “
“ E, B, D,	=	5,818 “

From which it appears that the transfer of business between your road and the Chicago and Northwestern, will be effected by a saving of about $3\frac{1}{6}$ miles ; and that of the other roads converging at E, by a saving of about $6\frac{1}{4}$ miles, if the bridge is located at B, instead of A.

It is, of course, impossible to determine with much accuracy, what will be the ultimate division of the business of the Union Pacific Railroad with the roads terminating on the opposite side of the river ; but, in the argument, I shall assume that *two-fifths* will be done with the Chicago and Northwestern ; and *three-fifths* with the other roads.

It is also assumed that the ruling grades will ultimately be the same, or thirty feet per mile, upon the lines connecting with each crossing.

The Chief Engineer estimates the cost of a low wooden truss bridge, located at A, with two draw openings of one hundred and sixty feet each, built upon stone abutments and piers, resting upon rock, or crib and pile foundations, together with trestle-work approaches, &c., at \$406,975 ; to which should be added the estimate of \$170,800 for the cost of constructing the line west of the depot grounds, upon a grade of thirty feet per mile, making a total of \$577,775.

He also estimates the cost of a high wooden truss bridge, located at B, without draw, resting upon stone abutments

and piers, with pile and crib foundations, together with the trestle approaches, and including the cost of one mile of road on the west side, at \$528,284.

It will probably be safe to assume that the cost of each line and river crossing, upon the general plans suggested by the Chief Engineer, including all contingencies, will be about the same, or say \$600,000 each.

VI.—VALUE OF DIFFERENCE IN LENGTH OF LINES.

The cost, and ruling grades being substantially the same for each crossing, it only remains to consider the effect, or value of the difference in the length of the respective lines.

In order to arrive at this result, even approximately, we should endeavor to ascertain from the best railroad experiences in the country, the value to the Union Pacific Railroad Company, of one mile in distance saved for all time, upon the traffic which is to pass over it.

Erie Railway.

The total movement of freight, or number of tons carried one mile on the Erie Railway, during the year ending September 30, 1865, was 388,557,212 tons. And the total expenses of operating the road, chargeable to freight transportation, during the same time, were \$3,460,821.67, or about one cent. per ton per mile.

Assuming that the operating expenses will be fifty per cent. greater on the Union Pacific Railroad, or one and a half cents per ton per mile; and that three freight trains of forty cars each, averaging eight tons per car, pass over the road daily in each direction, and we shall have \$28.80 per day, or \$10,512 per year, to represent the operating expenses, per mile, for transporting freight.

The number of miles travelled by passengers upon the same road, during the same time, or the number of passengers carried one mile, was 156,166,640; and the total expenses of operating the road, chargeable to passenger

transportation, were \$1,252,489.42, or about eight mills per passenger per mile.

Assuming that the expenses will be fifty per cent. greater on the Union Pacific Railroad, or one and two-tenths cents per passenger per mile; and that only five hundred passengers pass over the road, in both directions, per day, and we shall have \$6 per day, or \$2,190 per year, to represent the operating expenses, per mile, for transporting passengers.

The aggregate expenses for transporting freight and passengers per mile per year, would thus be \$12,702, which represents the interest, at seven per cent., on a capital of \$181,457. This does not include the cost of maintenance of way, repairs to machinery, nor the interest on the cost of the road.

Railroads of New York.

According to the report of the State Engineer of New York, for the year ending September 30, 1865, the average cost, during that year, for maintenance of way, repairs to machinery, and operating all the railroads in the State, was \$8,420.72 per mile run, of single track.

The average cost per mile, for construction and equipment, was about \$60,000; the interest upon which is \$4,200 per year, making, with the items above enumerated, an aggregate expenditure of \$12,620.72 per mile run of single track.

Assuming that all these items, except interest, will be at least fifty per cent. higher on the Union Pacific Railroad than they are in this State; and adding the interest at seven per cent. on \$70,000, the assumed average cost of construction and equipment per mile, and we shall have an aggregate expenditure of \$17,531.08 per mile run, per year, which represents the interest at seven per cent. on a capital of \$250,444.

This result being predicated upon the theory that the cost of operating railroads is in the ratio of their length, cannot be regarded as strictly correct when applied to a road of so great length as the Union Pacific; for the reason that the operating expenses per mile run, are generally diminished as the length of the road is increased.

It will undoubtedly be safe to assume, however, as a legitimate conclusion from the premises, that when the cost and grades per mile are equal, and with a business, say ten years hence, equal only to the average business of the railroads in the State of New York, and with a competition such as may be expected, a saving of one mile in distance on the Union Pacific Railroad will, as a general rule, be worth to the Company at least \$200,000, without taking into consideration the effect that this saving in distance may have upon the amount of business and receipts of the road for all time.

Exceptions to this rule may, and probably will occur, when an elongation of the line may not only be justifiable, but highly expedient for the purpose of reaching and controlling certain localities or trade; but nothing of this kind can be claimed as affecting the case now under consideration.

By applying the above result to the Bridge question we arrive at the following conclusions:—

A saving of \$200,000 per mile, on three and one-sixth miles, equals \$633,333. Two-fifths of this, or the amount of business apportioned to the Chicago and Northwestern Railroad, amounts to \$253,333. A saving of \$200,000 per mile, on six and one-fourth miles, equals \$1,250,000. Three-fifths of this, or the amount of business apportioned to the other roads terminating at E, amounts to \$750,000; adding to this the other two-fifths, makes an aggregate of \$1,003,333, or, in round numbers, one million dollars, in favor of the location at B; which, it will be observed, is one quarter of a million less than the expenditure already incurred upon the present line between the initial point and the junction at D.

VII.—PRACTICAL VIEW OF THE CASE.

Having thus demonstrated that, if the question was entirely open, and free from the complications and embarrassments resulting from the inconsiderate action of the President of the United States, in fixing the initial point of the road, without regard either to bridging the Missouri river, or a proper departure from it westward, the crossing

at B, will, in all probability be worth to the Company \$1,000,000 more than the crossing at A, we will proceed to examine more particularly the present practical bearing of all the facts, with a view of determining what, under the circumstances, is the best course for the Company to pursue.

An expenditure of about \$1,250,000 has, as heretofore stated, already been incurred upon the present line, between the Missouri river and the point D, which expenditure would be rendered comparatively worthless for the purposes intended, by a material change in the eastern terminus of the road; or which would practically amount to the same thing, the building of a bridge at the crossing B.

The extensive depot grounds, machine shops, engine houses, side tracks, &c., &c., at Omaha, are substantially all that will be required by the Company at the present terminus of the road during the time required for its construction, and probably for a period of ten years; and it is not probable that the business of the road will require a reduction of the grade immediately west of Omaha, from sixty-six to thirty feet per mile, before the expiration of that time.

The Chicago and Northwestern Railroad is the only one which promises to afford any material relief to your Company, in the way of a direct eastern railroad connection, during the next two or three years; and you will therefore be obliged to rely mainly upon it for much the largest proportion of the materials and supplies required for the construction and equipment of the next thousand miles or more of your road, as well as for the freight and passengers which must pass over it during that time.

By far the most important element in the future safety and success of the great enterprise which you have in charge, is its rapid and uninterrupted construction; and to secure this will require all, and perhaps more than all, the capital that may be placed at your disposal. It should, therefore, be only a matter of the greatest necessity that should induce you to divert one dollar of this capital to any other purpose than the extension of your road westward.

The unparalleled rapidity with which the Union Pacific

Railroad has been pushed forward up to the present time, in the face of all obstacles, has unquestionably done more towards establishing its credit upon a firm basis, and inspiring the public with confidence in its speedy completion, than any other means that could have been adopted by the Company.

How far any present additional expenditure that may be involved in the decision of this question, will be likely to affect the ability of the Company to push forward the entire work to a speedy and successful completion, is a question which the Directors alone are competent to decide.

The geography of the country, the necessities of commerce, and the present backward condition of the great competing lines heretofore mentioned, are such that the Union Pacific Railroad and its tributaries must, under any circumstances, enjoy a substantial monopoly of all the railroad transit between the Atlantic and Pacific Oceans during the next ten years; and therefore the advantages claimed for the shortest route for the location of the bridge, will in all probability not be fully realized before the expiration of that time, except as business may be diverted to branches connecting west of the Missouri river.

VIII.—SUGGESTIONS AS TO CROSSING “A.”

If the Board should decide upon the adoption of a location for the bridge, which will involve the greatest immediate benefits, and the least amount of present expenditure; and at the same time render most available the large expenditure already made, with a view also of waiting for the developments of time before determining upon the location and plan for a more durable and expensive structure, which may be better adapted to the accommodation of all parties that may then be interested in the question, I would respectfully suggest that a cheaper bridge than the one contemplated in the report and estimate of the Chief Engineer, may be constructed at or near the crossing A, which would answer the purposes proposed.

By following as nearly as possible in the location of the bridge, the bed of rock which underlies the river, either at or

just above the crossing marked A ; and by substituting crib and timber piers and abutments, filled with stone, for the solid masonry estimated for by the Chief Engineer ; and by reducing the height of the bridge above high-water mark, from twenty, to either ten, twelve, or fifteen feet, as may appear most expedient and, safe ; and perhaps, by reducing the spans from two hundred to one hundred and fifty feet each, I think that a bridge may be constructed at a cost of about \$350,000.

By entering vigorously upon the work at once, and getting the foundations above high water before the spring freshet, I think this bridge may be completed within from four to six months, depending somewhat upon the contingencies of high water during the spring and early summer months.

As soon as completed and ready for use, this bridge will save the Company from a daily expenditure of at least two hundred and fifty dollars, in the transfer of their materials and other business across the river ; and at that rate would pay for itself in less than four years from its completion.

It should be remarked, however, that the safety, or rather usefulness of a bridge at this point, would depend almost entirely upon the proper protection of the west bank of the Missouri river for a distance of about one mile above the bridge. This, it is assumed, will be done by the Company in any event, in order to protect its depot grounds from abrasion by the river ; and the expense should therefore not be charged to the construction of the bridge.

IX.—SUGGESTIONS AS TO CROSSING “B.”

If, on the other hand, the Board should feel prepared to locate the bridge in accordance with the general principles first considered, having in view the future interests of the Company, so far as they can be foreseen at or after a period ten years hence, I would respectfully advise that the location of the bridge be deferred until the future plans of the Chicago and Northwestern, and the Burlington and Missouri River Railroad Companies, so far as they relate to their ultimate connection with the Union Pacific Railroad, are more definitely understood, and some pledge given that they will be carried out.

So much uncertainty exists at the present time in relation to the future plans of these companies in this respect, that it has been deemed expedient to give prominence in the present discussion to the true interests of the Union Pacific Railroad Company, as they are believed to be involved in the rapid and uninterrupted construction of its road westward, rather than to speculative theories as to the future action of these companies, which, when fully decided upon, will be likely to involve considerations with reference to its connections, not only with Chicago, but with St. Joseph, St. Louis, Pittsburgh, Cincinnati, Philadelphia, Washington, New York, and Boston; which may prove of much greater importance to this Company than the mere present cost of constructing a bridge upon any particular plan or location.

If the Chicago and Northwestern Company have it in contemplation to construct a road within a few years, from the mouth of the Boyer Valley, upon the most direct and practicable line westerly, to an intersection with the Union Pacific at Fremont, North Bend, or Columbus; and if the Burlington and Missouri River Company have it in contemplation to connect exclusively and permanently with the Union Pacific at the crossing of the Missouri river, in case the bridge is located at some point convenient for such connection—then the question may well be raised whether, under all the circumstances, the permanent bridge should not be located and constructed still farther down the Missouri than point B, at a point opposite the mouth of the Papillon Valley.

Whenever the bridge shall be permanently located, either at B, or any other point upon the river, where the approaches will admit, I would respectfully recommend the construction of an iron truss bridge, upon solid stone piers and abutments; and sufficiently high to clear the chimneys of steamboats navigating the river at high water. I would also recommend that the masonry, or sub-structure, be constructed for a double-track bridge, so that an additional line of truss may be thrown across at any time when the business requires the additional facilities of a double track.

The advantages of an iron bridge over a wooden one,

one, are, its greater durability, its susceptibility of spanning greater lengths, and the reduced lateral surface which it exposes to the wind. The advantage of a high bridge over a low one is, the avoidance of a draw, which is a constant source of danger and expense; and should therefore be dispensed with upon a railroad whenever it is reasonably practicable to do so.

The nearest point to the present depot-grounds at Omaha, where I would regard the construction of a high bridge as at all practicable, is situated about one and half miles below the point A, where the bluff upon the west side approaches to within about fifteen hundred feet of the river. And it is quite probable that a line may be obtained, at moderate expense, from this point, with maximum grades of thirty feet per mile, that will intersect the present track about one mile southwesterly from the summit west of Omaha.

I do not feel quite prepared, at the present moment, to recommend any particular plan of iron bridge for adoption by the Company; but can do so very soon, should the Board decide to construct one. My opinion, however, is, that such an iron bridge superstructure as I would recommend, will cost at least \$150 per lineal foot, in spans of two hundred feet each, with single track.

The Chief Engineer estimates the cost of a high wooden truss of two hundred feet span, at \$65 per lineal foot, for a length of two thousand feet. Estimating the same length of iron truss at \$150 per lineal foot, will make an increase in cost for this item of \$170,000. He also estimates the aggregate cost of sub-structure for single track, at \$135,355; estimating fifty per cent. additional for the cost of adapting the sub-structure to a double track, will make an increase for this item of \$67,677.50, which, with the additional cost of iron superstructure (\$170,000), and \$600,000 hereinbefore assumed as the probable cost of a high bridge and mile of track upon the plan suggested by the Chief Engineer, makes an aggregate of \$837, 677.50, or, in round numbers, \$850,000; being \$500,000 more than the low wooden truss at A.

It is not probable that such a bridge as is above described can be properly located and constructed in less than eight-

een months or two years. And the Company would therefore be obliged to incur the expense of the transfer of freight and passengers, as well as materials for constructing the road, across the river by ferry, during a period of at least one year longer, if this plan, instead of a temporary bridge at A, is adopted. This item, computed at \$250 per day, would amount to \$91,250, which, with the estimated additional cost of the bridge (\$500,000), would make an aggregate of \$591,250 (say \$600,000), to represent the extra amount of present expenditure chargeable to the crossing at B; which amount, it will be observed, is, in round numbers, \$400,000 less than the ultimate additional value claimed for this crossing.

I shall take the liberty of appending to this report, for the information of the Board, copies of correspondence with Mr. Samuel B. Reed, General Superintendent, in relation to the probable amount of passengers and tonnage; and the cost of ferriage during one year—with Mr. John E. Roebling, and Messrs. Post, McCallum & Co., upon the subject of iron truss and suspension bridges—and with Mr. L. B. Boomer, respecting a cheap plan of wooden-truss bridge with the necessary draw openings.

X.—BRIDGING THE MISSOURI AN EXPERIMENT.

Nothing has been said, thus far, respecting any extraordinary difficulties that may be apprehended in constructing a bridge over the Missouri river, upon any plan or location that the Company shall think proper to adopt.

Before leaving the subject, however, I deem it proper to state, for the information of the Board, that the bridging of the Missouri river, at any point between the head of navigation and its mouth, is as yet an untried experiment. And that a very wide difference exists in the opinions of men of great experience and sound judgment in such matters, as to whether it can be successfully done at all; or if done, as to the proper mode of doing it.

The river bottoms are generally from three to five, and sometimes ten miles in width; and are composed of an im-

mense deposit of alluvium, consisting of quicksand, clay, and earth, or vegetable matter, varying in depth from twenty to fifty, and sometimes probably one hundred feet; and resting generally upon a sub-stratum of hard sand or gravel, and, in some instances, of rock.

It is a common, and not unapt remark, that the Missouri river has a standing mortgage upon the whole of these bottoms, the truth of which is pretty well established by the fact, that it undoubtedly has, at different periods of time, occupied nearly, if not quite all the territory between the adjacent bluffs; and the indications are that it may do so again at some future time.

The river itself seems to cut its way through these bottoms at pleasure, sometimes up, down, and across, at all points of the compass, just as an apparent freak, or the smallest assignable cause, may happen to direct it. The bed of the river is also in a state of constant transition within its own banks, so that during stages of low water, the steamboat channel shifts, sometimes daily and even hourly, from one side of the river to the other.

The chief difficulties, therefore, to be apprehended in the construction and permanent usefulness of a bridge, are threefold in their character:—

1st. Controlling permanently the position of the river, so that it will always pass under the bridge, instead of cutting its way across at either end; or, perhaps, opening a new channel several miles distant.

2d. Controlling the navigable channel, so that it will always pass through the draw openings (if the bridge be a low one) instead of under a span several hundred feet distant. And

3d. Securing permanent foundations for the sub-structure of the bridge.

A somewhat careful observation and study of the river, at intervals during the past three years, extending from De Soto to Kansas City, a distance by the river of more than five hun-

dred miles ; and also at different points between Kansas City and its mouth, has satisfied me that, at certain localities, and within certain limits, all these difficulties may be successfully overcome, by the exercise of proper skill and judgment in the location and construction of the bridge ; and a suitable protection of the banks and channels, both at and for some distance above the crossing ; all which has been assumed with reference to the crossings herein referred to.

Inasmuch, however, as a proper discussion of this branch of the subject would probably take a somewhat extended range, and might not be regarded as in all respects pertinent to this report, I will defer it until a future time, in case the Company, after deciding upon the general principles of a location, shall desire an expression of my views.

XI.—CONCLUSION.

This report has prolonged itself much beyond the limits to which I had originally assigned it.

It has been my purpose, not to advocate any particular location for the bridge, but to spread before the Board such a view of the most important facts and considerations bearing upon the whole subject, as would enable them to decide the matter intelligently ; and in such a manner as would stand the test of time and circumstances.

If I have succeeded in this, I shall feel more than repaid for the thought and labor bestowed upon it.

Respectfully submitted.

SILAS SEYMOUR,

CONSULTING ENGINEER.

TO THE HON. OLIVER AMES,

PRESIDENT, *pro tem.*,

UNION PACIFIC RAILROAD CO.

APPENDIX.

CORRESPONDENCE WITH MR. SAM'L B. REED, GEN'L SUPT. AND ENGINEER IN CHARGE
OF CONSTRUCTION UNION PACIFIC RAILROAD.

UNION PACIFIC RAILROAD, ENGINEER DEPARTMENT,
No. 20 NASSAU STREET, NEW YORK, Dec. 18, 1866.

SAM'L B. REED, Esq.,

Gen'l Supt. and Engr. in charge of Construction.

DEAR SIR : Having been called upon by the Company for a report upon the bridge across the Missouri river, at the eastern terminus of the road, and as the question of time is an important element in the matter, will you oblige me by furnishing an approximate estimate of the travel and tonnage that may be expected to cross the river at that point, per day or year, to and from the Union Pacific Railroad, during the next two years ; and the probable cost of the same, if done by ferry ; upon the assumption that seven, or perhaps eight hundred miles of the road are to be completed within that time.

Yours truly,

S. SEYMOUR,

Consulting Engineer.

NEW YORK, Dec. 21, 1866.

Col. S. SEYMOUR,

Consulting Engr., U. P. R. R.

DEAR SIR : Yours of the 18th instant, asking for information about the amount of freight and the number of passengers that would pass over a bridge, at the eastern terminus of the Union Pacific Railroad, and the approximate cost of crossing the same over the Missouri river by ferry, is received.

As near as I can ascertain, the freight sent to the Mountains, from the Missouri river, will be about as follows :—

Colorado.....	10,800 tons.
Montana and Idaho.....	10,800 “
Utah	7,400 “
Government Freight.....	20,000 “
Total	<u>49,000 “</u>

One-half (estimated) will cross the Mis-	
souri river at Omaha.....	24,500 tons.
R. R. Freight, Iron, Chairs, etc.....	35,000 “
Omaha and Northern Nebraska.....	5,500 “
Total tonnage to cross the river...	<u>65,000 “</u>

Passengers, estimated.....10,000

Cost of ferriage at present rates, \$2 50 per ton. This rate may be reduced to, for merchandise and government freight, \$1 50, and on railroad freight to \$1 25 per ton.

ESTIMATE.

30,000 tons private and government freight at \$1 50.....	\$45,000
35,000 tons railroad “ “ 1 25.....	43,750
10,000 passengers “ 25.....	<u>2,500</u>
Total per annum.....	\$91,250
For one day.....	250

Yours very respectfully,

SAM'L B. REED,

Gen'l Supt. and Chief of Construction.

CORRESPONDENCE WITH MR. J. A. ROEBLING.

UNION PACIFIC RAILROAD, ENGINEER DEPARTMENT,
No. 20 NASSAU STREET, NEW YORK, Dec. 7, 1866.

JOHN A. ROEBLING, Esq.,
Civil Engineer, etc., Trenton, New Jersey.

DEAR SIR: This Company is now considering the subject of bridging the Missouri river in the vicinity of Omaha, Nebraska; and I would like to lay before them a plan and estimate for a suspension railroad bridge, somewhat similar to the one which I understand you have so successfully completed over the Ohio river, at Cincinnati.

The bridge may be so located that one end will abut against the bluff; but the other, or east end, must in any case land upon the river bottom, below high-water mark. There must be at least fifty feet in the clear, between high-water mark and bottom of bridge, and the maximum grade ascending westerly, to and from the bridge, will be thirty feet per mile.

The difference between high and low water, in the river, is about twenty feet.

Two spans of one thousand feet each, together with the trestle-work approach of one and a half miles at the eastern end, will afford sufficient water-way.

The foundations, I fear, will be somewhat difficult and expensive, the bed of the Missouri being quite changeable, and composed principally of quicksand; and it is on this account that the idea has occurred to me that a suspension bridge may be better adapted to the locality, than one requiring foundations every two hundred feet, and a draw for the passage of steamboats.

I trust that the above data will enable you to give me some general idea of the practicability, as well as cost, of constructing a suspension bridge.

I would like also to know the probable time that you would require to construct one.

By favoring me with an early reply, you will much oblige,

Your obedient servant,

S. SEYMOUR,

Consulting Engineer, U. P. R. R.

OFFICE COVINGTON AND CINCINNATI RAILROAD COMPANY,
CINCINNATI, December 12, 1866.

S. SEYMOUR, Esq.—

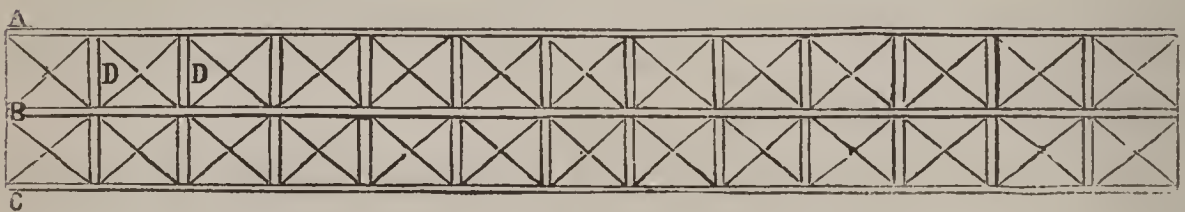
DEAR SIR: Your inquiry of the 7th came to hand.

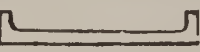
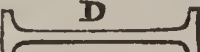
I cannot recommend you to advise the adoption of *large* suspended spans over the Missouri river, knowing beforehand, that the great cost of such a work will defeat the project. I would, however, advise an intermediate plan, which will, in your case, reduce the cost of foundations one half, and will less impede the navigation.

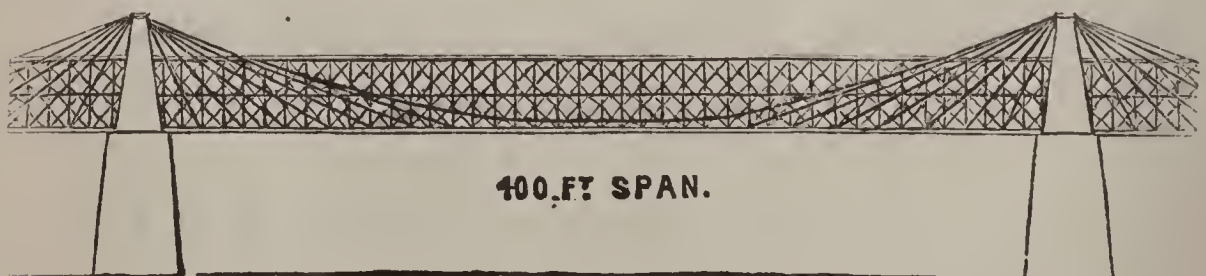
I would recommend to you, spans of three hundred and fifty to four hundred feet, iron truss, of such strength as will support their own weight; assisted by wire ropes, so that the latter will support the transitory loads. This plan, which I have carried out on a smaller scale, is equally valuable on a large scale; and will when once understood, be found the most economical and *safest* plan of any that has been brought forward.

Of the various principles of trussing now in vogue, I prefer the plan which I have introduced in the Niagara Bridge, and in this bridge.

You should want a truss, say of twenty-five feet depth.



The truss rods nearly at right angles, the chords *a, b, c*, made of channel, or trough bars , enclosing the wrought-iron posts , and rivetted to it. No cast-iron pieces except blocks for the ends of the rods to pass through, at end of posts. Now make this strong enough to support itself; and suspend wire cables on each side of truss, for support of loads, in similar way as was done to *save* the Rock Island, and other large spans of wooden truss bridges. The following sketch will explain the arrangement.



On the piers, cast iron, or wrought-iron columns, or pieces are put up in a pyramidal form, connecting with the trusses, which serve as towers for support of wire cables (indicated by curved lines). The cables to extend from abutment to abutment, and anchored at both ends, to relieve the chords of all strains in consequence of their tension. The trusses are furthermore strengthened by wire-rope stays, to such an extent that the same proportions of the trussing parts may be preserved from pier to pier. This is a very important and economical feature, you will perceive.

The trusses and stays combined, will be a perfect system within itself, fully ample to support its own weight. The cables will take care of the loads. The whole plan is simply a truss bridge, assisted by cables.

The enormous cost of those lattice bridges in Germany, over the Rhine (three hundred and thirty feet span), Oder and Weichsel, will not only by this system be reduced more than one half, but the spans may be safely enlarged.

The contraction and expansion of the trusses is easily managed.

Should you eventually accept such a plan, I will then explain more fully. I have no time *now* to make plans or estimates. You can plan and estimate the trusses yourself.

As to strength of cables allow a train of three hundred tons to cover one span ; this would require twenty No. 1 wire ropes, costing per span thirteen thousand dollars, or thirty-two dollars per foot, lineal, of superstructure. From this you will see at once how *economical* the proper application of wire cables is, to say nothing of safety and saving of foundation work, and larger spaces for navigation.

I will be at home after New Year's, and if you wish me to call in New York, I will do so.

Respectfully yours,

JOHN A. ROEBLING.

CORRESPONDENCE WITH MESSRS. POST, McCALLUM & CO.

UNION PACIFIC RAILROAD, ENGINEER DEPARTMENT,
No. 20 NASSAU STREET, NEW YORK, *Dec. 7, 1866.*

Messrs. Post, McCallum & Co.,
(*Atlantic Bridge Works*),
No. 157 Broadway, New York.

GENTLEMEN : This Company is now considering the subject of building a railroad bridge over the Missouri river, in the vicinity of Omaha, Nebraska, and I would like to submit to them a plan and estimate for an iron bridge, as designed by your Mr. Post ; and also of one composed of part iron and part wood, which, I believe, you construct upon the same general principle.

The bridge will be about two thousand feet long, and if built without a draw, must be at least fifty feet in the clear, above high water. The difference between high and low water is about twenty feet.

If a low bridge is built, the lower chord must be at least fifteen feet above high water, and the draw should have as large an opening as practicable.

The spans should not be less than two hundred feet each.

You would oblige me by furnishing me with a general plan and estimate, both for a high and low bridge, at your earliest convenience.

Yours very respectfully,
S. SEYMOUR,
Consulting Engineer.

" ATLANTIC BRIDGE WORKS,"
NEW YORK, *December 29, 1866.*

COL. S. SEYMOUR,
Consulting Engineer, U. P. R. R.
20 Nassau street, New York.

DEAR SIR : In answer to your inquiry as to the cost of a bridge over the Missouri river, at Omaha, Nebraska, about "two thousand feet in length, and fifty feet above high water if without a draw, or fifteen feet above high water if a draw is used," the following estimate is respectfully submitted :—

For an iron bridge, with iron floor beams, raised, and ready to receive the rails :

Spans of 400 feet from cen. to cen. of piers, \$365 per lineal foot.

Do	333 $\frac{1}{3}$	"	"	"	"	265	"	"
Do	250	"	"	"	"	185	"	"
Do	200	"	"	"	"	145	"	"
Do	150	"	"	"	"	100	"	"
Do	100	"	"	"	"	80	"	"

For a draw-bridge, with two openings of one hundred and sixty feet each in the clear, and a total length of three hundred and sixty-five feet ; entirely of wrought iron :

\$235 per lineal foot, including turn-table complete.

For the "Combination Wood and Iron Truss Bridge," with wooden floor beams, raised and ready to receive the rails, as follows :

Spans of 259 feet from cen. to cen. of pier, \$125 per lineal feet.

Do	200	"	"	"	"	95	"	"
Do	150	"	"	"	"	75	"	"
Do	100	"	"	"	"	60	"	"

The timber used in either the iron or combination bridge, to be "Burnetized."

In the foregoing estimate, the bridges are assumed to be of a sufficient strength to be strained to only one-sixth of their ultimate capacity, by a moving load of two thousand five hundred pounds per lineal foot.

It is assumed that railroad transportation can be had for the materials, etc., to the bridge site.

Accompanying this, are plans showing the general construction of the bridges estimated for.

Very respectfully, your obedient servants,

POST, McCALLUM & Co.

CORRESPONDENCE WITH MR. L. B. BOOMER.

UNION PACIFIC RAILROAD, ENGINEER DEPARTMENT,
No. 20 NASSAU STREET, NEW YORK, *Dec. 18, 1866.*

L. B. BOOMER, Esq.,
Chicago, Ill.

DEAR SIR: Will you be good enough to inform me, by return mail, if possible, how soon it would be practicable for you to frame and deliver upon the east bank of the Missouri river, opposite Omaha, say two thousand lineal feet of Howe Truss Bridging, in spans of one hundred and fifty feet each, together with a turn-table, and draw, with two openings of one hundred feet each; and also the length of time that it would require to raise the entire structure, provided there was no detention from high water, or other unforeseen causes.

Please inform me, also, of the lowest price per lineal foot, at which you would be willing to contract for the structure complete, upon the assumption that the plan and materials are to be as economically arranged as may be consistent with necessary strength and durability for a period of from eight to ten years.

The foundations of the bridge are expected to be upon rock from eight to ten feet below low-water mark, and extending from one-half to three-quarters of the distance across the river, and the balance of the distance upon pile and crib foundations.

I would like, also, your price, per foot, for truss of two hundred feet span and draw, with one hundred and fifty feet openings, with time required to build them.

Please answer as promptly and fully as possible, and oblige,
Yours very respectfully,

S. SEYMOUR,
Consulting Engineer.

CHICAGO, *December 22, 1866.*

COLONEL S. SEYMOUR—

DEAR SIR: Yours of the 18th instant inquiring how soon it will be practicable for us to frame and deliver you a bridge two thousand feet long, upon Howe's patent, consisting of spans one hundred and fifty or two hundred feet long, with a draw of two

openings of one hundred and fifty feet each, and a price for the same, "upon the assumption that the plan and materials are to be as economically arranged as may be consistent with necessary strength and durability for a period of from eight to ten years," is at hand.

We can furnish and deliver the bridge on cars in Chicago, of either span you mention within ninety days, and raise the same in from forty to sixty days thereafter, if not detained for the want of transportation, masonry, the elements, or any cause not our fault.

We can build such a bridge for the following prices per lineal foot—we furnishing all of the materials used, and performing all the labor, exclusive of transportation from Chicago to the bridge location :

For spans 150 feet long.....	\$44 00
Do. 200 ".....	56 25
For draw of two openings of 150 feet each	100 00
Add for turn-table.....	6,500 00

These prices are predicated upon ordinary height for false bridge. Should it be over an average height, or any piles be required for the same, then we should make an additional charge for them.

Yours respectfully,

L. B. BOOMER,

For Boomer, Boyington & Co.

3 - APR 22
Copy _____ 1958

UNION PACIFIC RAILROAD.

SUPPLEMENTAL REPORT

OF THE CONSULTING ENGINEER

*On Bridging the Missouri River at the Eastern Terminus of
the Road.*

Engineer Department,

NEW YORK, March 24, 1868.

SIR:

On the 31st December, 1866, I had the honor to submit a "Report on the Location and Construction of a Bridge across the Missouri river, at the eastern terminus of the Union Pacific Railroad."

That report was based upon information contained in a report upon the same subject, submitted by the Chief Engineer under date of December 3d, 1866; which information was somewhat meagre in its details, although it was considered sufficiently reliable to enable us to arrive at substantially correct conclusions in comparing the relative advantages of the different routes proposed for discussion.

The conclusions arrived at in my former report may be briefly stated as follows: 1st, If the company desire to build a bridge within the shortest possible time, for the least amount of money, and with a view of deriving the greatest amount of benefit from it during the construction of the road, and perhaps for a period of ten years to come, then throw across a low, wooden bridge, with draw, at some point, either at, or just below what is known as the telegraph

crossing. It was assumed that this could be done for about \$350,000. 2d. If the company should decide to build a permanent bridge at a point to be mutually agreed upon, that should accommodate not only its own traffic, but the traffic of all its eastern tributaries for all time, then it was recommended that, if the approaches would permit, a high bridge, without draw, with iron superstructure and permanent stone piers be built, at an estimated cost of about \$850,000.

The following remark was made with reference to the location of this permanent bridge: "I would respectfully advise that the location of the bridge be deferred until the future plans of the Chicago and North-western, and the Burlington and Missouri River Railroad Companies, so far as they relate to their ultimate connection with the Union Pacific Railroad, are more definitely understood, and some pledge given that they will be carried out."

Up to the present time it appears that the different railroad interests upon the east side of the river, have not been able to agree upon a common focal point at which they will all converge, for the purpose of transferring their business to and from the Union Pacific Railroad; and it therefore appears to be premature to attempt to locate and construct a bridge that shall necessarily force such a combination of these interests as will induce them either to render the necessary aid in its construction, or to obligate themselves to use the bridge for any length of time after its construction. The interests of the Chicago and North-western and the Burlington and Missouri River Railroad Companies appear to be too adverse to afford any reasonable promise that they will ever come together permanently at a common point upon the east side of the river. The former company will not go below the Bellevue Peninsula, and the latter will not go above it.

The Chicago, Rock Island and Pacific Railroad will enter the Missouri Valley between the respective points urged by the other two companies for bridging the river; and has, therefore, up to the present time, manifested no decided preference

upon the subject. The Council Bluffs and St. Joseph Railroad is already constructed from the western terminus of the Chicago and North-western, a distance of thirty or forty miles down the Missouri Valley; and, being a lateral road, can have no direct interest in the decision of the question. In deciding the question at the present time, it therefore appears that the Union Pacific Railroad Company must consult its own interests, and leave the conflicting interests of its eastern tributaries to be harmonized at some future time.

The bridge should undoubtedly be built at once, provided its cost can be brought within such limits as not to embarrass the company in the rapid construction of the road.

If it had been built during the past season upon the cheap plan suggested in my report, there can be no doubt that it would have earned for the company at least one hundred thousand dollars up to the present time, and the earnings would probably be double or treble that amount during the present year.

The questions, then, to be considered are:

1st. The location of the bridge.

2d. The kind of bridge to be constructed.

It is proposed to discuss these questions purely with reference to the present interests and necessities of the Union Pacific Railroad Company.

The data as to length and cost of the different lines (unless otherwise specified), will be taken from the report of the Hon. Jesse L. Williams, recently submitted to the board, upon the same subject.

LOCATION.

Having failed to secure the co-operation of the Burlington and Missouri River Railroad Company in the construction and use of a bridge, unless it be located considerably south of a point to which the Chicago and North-western Company will go; and as the latter road is the only one that can be relied upon (in connection with the Missouri river) to furnish the necessary transportation facilities for constructing the

road, there will be no occasion, in the present aspect of the case, to discuss the Bellevue crossing, except to state that its cost will be about the same as the Childs' Mill crossing, and its comparative length and grades much more favorable than any other route that can be suggested.

I have never entertained a doubt, that if the President of the United States had been fully aware of the great advantages of this locality, he would have fixed the initial point of the road, with reference to a crossing, opposite the mouth of the Pappillon Valley, instead of the point designated by him above Omaha City.

The first point, therefore, to be considered, will be the crossing, with a high bridge at

CHILDS' MILL.

This point lies nearly in an air line between the natural point of convergence of the three lines of railroad, terminating, or to terminate at Council Bluffs, and the southerly bend of the Union Pacific Railroad, where it leaves Mud Creek, and enters the Pappillon Valley.

The advantages claimed for this crossing are: 1st, its directness or saving in distance; 2d, its adaptation to a high bridge; and 3d, its cheap construction, as compared with the locality at South Omaha, having in view the ultimate reduction of the grades west of Omaha to a maximum of thirty feet per mile.

The disadvantages claimed for it are: 1st, the virtual abandonment and loss of all the expenditures heretofore made by the company at Omaha, and on the line of the road as far west as the intersection; 2d, the violation of implied obligations to the Government and people, consequent upon the abandonment of a line upon which the company has received the Government subsidy under the approval of the President of the United States, and which has been given out as the permanent terminus of the road, on the faith of which announcement a large amount of private capital has been invested in and about Omaha; 3d, the necessity of incurring a much larger present expenditure than would

be chargeable to the construction of a bridge at points further up the river, where an intersection could be made directly with the present line at or near Omaha; and 4th, the necessity of maintaining and operating that portion of the road between Omaha and the point of intersection (near the mouth of Mud Creek Valley) which would be virtually abandoned for through business.

The estimated present cost of the bridge and approaches at this crossing is \$1,432,131, and the "total capital" chargeable to it is \$1,632,131.

The next point to be considered will be the crossing with a high bridge at

SOUTH OMAHA.

This point is situated about three fourths of a mile below the present machine-shops of the company, at Omaha, and it is proposed to connect the westerly approach of the bridge with what is known as the "Ainsworth line" (having a ruling grade of thirty feet per mile), and to intersect with the present road near the intersecting point of the Childs' Mill line. It is also proposed to connect, by means of a short branch, with the present depot grounds and shops of the company, although the business depot will be located upon what is known as the "Train table" in South Omaha.

The advantages claimed for this crossing are: 1st, its virtual compliance with the implied obligations of the company to the Government and people with reference to the terminus of the road, as fixed by the President of the United States; and 2d, its proximity to the present shops and depot grounds of the company, which will render them available to some extent for future use.

The disadvantages claimed for it are: 1st, its greater length of two and a half miles (*via* the Ainsworth line) than the Childs' Mill crossing; and 2d, its greater present and ultimate cost, as compared with the Childs' Mill line.

The estimates of cost and distance are computed by Mr. Williams with reference to an intersection with the present road west of the summit, and reducing the grades upon the

present line to thirty feet per mile. The probable difference in the cost of doing this, and the construction of the Ainsworth line, which he estimates to be one mile shorter, will be so trifling, that I shall apply his estimates as they stand to the Ainsworth line.

The estimated present cost is \$2,093,604; and the total capital chargeable to it (after deducting \$79,200, as the cost of running one extra mile less than assumed by Mr. Williams), is \$2,346,356.

The difference, therefore, so far as the foregoing comparison extends, is \$661,473 in present expenditure, and \$714,225 in total capital invested, in favor of the Childs' Mill, as against the South Omaha crossing.

I beg leave to submit, however, that the company, in finally deciding this question, should charge each of the crossings with its proportionate amount of the loss, or deterioration in value, to the company, of the expenditures already incurred at the eastern terminus of the road, embracing the road and track now in use from Omaha to the junction, and the depot grounds, shops, buildings, sidings, &c., at Omaha.

It was stated in my report of December 31, 1866, that "An expenditure of about \$1,250,000 has already been incurred upon the present line, between the Missouri river and the point 'D' (junction), which expenditure would be rendered comparatively worthless for the purposes intended, by a material change in the eastern terminus of the road; or, which would practically amount to the same thing--the building of a bridge at the crossing 'B' (Childs' Mill)."

By charging the Childs' Mill crossing with this amount, \$1,250,000, and charging the South Omaha crossing say \$250,000, on account of its want of proximity to the present depot grounds, and the ultimate abandonment of the present track to the junction, we should have, to represent present cost:

Childs' Mill crossing.....	\$2,682,131
South Omaha ".....	2,343,604

Difference in favor of South Omaha....	<u>\$338,527</u>
--	------------------

And to represent total capital :

Childs' Mill crossing.....	\$2,882,131
South Omaha "	2,596,356
Difference in favor of South Omaha.....	<u>\$285,775</u>

LOW BRIDGE CROSSING.

At the request of yourself and some of the other directors, I have prepared with some care, plans and estimates for a bridge to be located at any point, which may be considered most safe and expedient, between the South Omaha crossing and the point known as the "Telegraph Pole crossing" just above the present depot grounds at Omaha.

The plan contemplates a bridge about two thousand feet long, with iron superstructure throughout. The lower chord to be fifteen feet above high-water mark. A pivot-draw with two openings of one hundred and sixty feet each in the clear. The permanent spans to be two hundred feet each from centre of piers. The foundations to be of cast-iron cylindrical columns, averaging seventy-two feet long, and extending from the lower chord to a permanent bearing underneath the river bed.

The estimated cost of this structure complete (except approaches) is \$625,000.

Inasmuch as the eastern end of the bridge may be made to connect with the present track of the Chicago and North-western Railroad, which runs down to the Missouri river, and the west end with the tracks upon the present depot grounds at Omaha, the cost of approaches will be comparatively slight, but they are assumed at \$25,000, making the total cost of bridge and approaches \$650,000.

The protection of the river banks above, and at the site of the bridge—together with the direction of the navigable channel through the draw openings, so far as expenditures on these accounts would be likely to exceed the cost of protecting the river banks above the high structures at South Omaha and Childs' Mill—should be charged to this crossing in any comparison that may be made between them.

Without undertaking at the present moment to specify the probable nature and extent of these expenditures, I will proceed to institute a comparison between this and the two proposed high crossings below it, in order to show what expenditures the company could afford to make, or what risks they would be justified in taking, in order to secure the advantages of this crossing during the next five or ten years.

The advantages claimed for this crossing are :

1st. It can be constructed during the present year, or certainly within one half the time that either of the high structures below it can be constructed. This consideration is estimated to be worth to the company at least \$100,000.

2d. The expenditure required to bring it into use (exclusive of river work), will be only \$650,000, which is \$1,443,604 less than the South Omaha crossing, and \$782,131, less than the Childs' Mill crossing, exclusive of loss or deterioration in value of shops, &c.

3d. It renders available, to the fullest extent, all the expenditures heretofore made by the company between the initial point and the junction near the mouth of Mud creek. Assuming this expenditure to be \$1,250,000, and the credit would be say \$250,000, as against the South Omaha crossing, and \$1,250,000 as against the Childs' Mill crossing.

4th. It enables the company to concentrate the railroad and river traffic substantially at one point, at or near its western terminus, thus avoiding the construction of a branch track for the accommodation of the river traffic.

5th. Inasmuch as this crossing does not involve any immediate change in the present line and grades west of Omaha, it enables the company not only to defer that expenditure, but to avail itself of any better route that may yet be found between the initial point and the Platte Valley.

6th. It enables the company to comply fully with all the legal and moral obligations growing out of their charter and

their past policy respecting the eastern terminus of the road, thus securing the good-will and co-operation, instead of the active hostility of the inhabitants of a large and growing town at its eastern terminus. The value of this cannot, of course, be computed in dollars and cents. None will deny, however, that *something*, perhaps *much*, should be credited to this crossing on that account, particularly as against the Childs' Mill crossing.

The disadvantages claimed for this route are :

1st. The difficulties attending the proper control of the banks and channel of the river, in order to secure the permanency of the structure, and avoid any material obstruction to navigation.

2d. Its greater length. This will depend somewhat upon the ultimate location of the point at which the roads will converge upon the east side of the river, as well as upon the point selected for crossing the river.

I will assume that it is one mile longer than the South Omaha crossing, and three miles longer than the Childs' Mill crossing. Computing this excess of distance by the value (\$79,200), estimated by Mr. Williams of one mile saved, and the result shows for this item \$79,200 in favor of the South Omaha crossing, and \$237,600 in favor of the Childs' Mill crossing.

Mr. Williams estimates the cost of grading and masonry upon the Ainsworth line, from the present shops to its intersection of the main line, at \$175,743, which amount should also be included in the total capital to be invested in this line, with a view to an ultimate reduction of the grades to thirty feet per mile.

The following summary will show the comparisons between the respective crossings, exclusive of expenditures to be incurred in protecting the river banks and controlling the navigable channel :

SUMMARY.

NATURE OF EXPENDITURE.	DESIGNATION OF CROSSING.		
	CHILDS' MILL.	S. OMAHA.	LOW BRIDGE.
Present Expenditure required to open line for use.....	\$1,432,131	\$2,093,604	\$650,000
Total Capital to be invested as per Mr. Williams' report.....	1,632,131	2,425,556	.....
Deduct value of one mile saved by Ainsworth line.....	.....	79,200	.....
		2,346,356	
Add for loss on shops, &c.....	1,250,000	250,000	.....
Comparative Total Capital....	2,882,131	2,596,356	.. ..
Add for constructing Ainsworth line...	.....	... ..	175,743
Add for increased distance over South Omaha line.....	.....	.....	79,200
Comparative Total Capital.....	.....	2,596,356	904,943
Add for increased distance over Childs' Mill line two miles additional .....	.....	.....	158,400
Comparative Total Capital.....	2,882,131	.....	1,063,343

The following results are deduced from the above summary:

1st. The present expenditure upon the South Omaha crossing, exclusive of the loss on shops, &c., will be \$661,473 more than upon the Childs' Mill crossing.

2d. The total capital to be invested in the South Omaha crossing, including the loss on shops, &c., will be \$285,775 less than in the Childs' Mill crossing.

3d. The present expenditure upon the low bridge crossing, exclusive of the loss on shops, &c., will be \$1,443,604 less than upon the South Omaha crossing, and \$782,131 less than upon the Childs' Mill crossing.

4th. The total capital to be invested in the low bridge crossing, including the reduction of grade, loss on shops, &c., will be \$1,691,413 less than in the South Omaha crossing, and \$1,818,788 less than in the Childs' Mill crossing.

RIVER EXPENDITURES.

From the foregoing differences, in the comparison of the low bridge crossing with the other lines, must be deducted the cost and risks attending the permanent adaptation of the river and channel to the locality of the bridge and draw-openings, in such a manner as to secure the safety of the structure and not to impair the usefulness of said river for navigation to any greater extent than such structures of the most approved character necessarily do.

The difficulties to be apprehended in attempting successfully to control the Missouri river, within reasonable limits, have, in my opinion, been very much exaggerated in all previous reports upon the bridge question. I certainly find that my own views have been materially modified since my first observation of the river.

The first high water that came upon us after the grading of the depot grounds and construction of the shops at Omaha, was in the spring of 1866. I was at Omaha and watched the effect with great solicitude and alarm. On the 24th April, I telegraphed to Dr. Durant, who was then on his way to Omaha, as follows: "Prospect of river breaking through to Nebraska Bluffs and leaving sand hills on island." To which the doctor replied: "Don't be alarmed—the river won't wash the bluffs during your day. You may lose a little of the track near initial point, but the most of it will be all right—I will insure it for a trifle."

The doctor arrived at Omaha by steamer from St. Joseph, during the highest stage of the water; and after carefully examining the condition of the river, a portion of which was then rushing over the flats between the company's shops and the sand hills, predicted that the only material change produced by the flood would be the washing away of a portion of the bank below the initial point, and the formation of a bar below the telegraph poles, which would be caused by the diversion of the current toward the Iowa shore.

His theory proved to be perfectly correct. A small portion of the road-bed below the initial point was washed away, after the track had been removed from it. A bar was formed

below the telegraph poles. The current set with more than its previous force against the Iowa shore ; and with these exceptions, the river resumed substantially its former bed for another year.

In the spring of 1867 we had another and still higher flood. Yourself and a number of the other directors arrived in time to witness its full effects. The indentation in the Nebraska shore, below the initial point, became deeper ; so much so that it deflected the current more strongly against the Iowa shore opposite the telegraph crossing ; and, finding no obstacle to resist it, commenced undermining and washing it away. This formed a large eddy on the Nebraska side below the telegraph poles, and the bar was extended further down the river. It also gave the current a shoot against the Nebraska shore, opposite the Train table, and commenced washing it away.

These abrasions upon one side of the river, and the formation of bars upon the other, will undoubtedly continue from flood to flood, or year to year, so long as no obstacle is placed in the river at the proper point to prevent it.

I have no doubt that if, after the flood in 1866, a crib filled with stone and properly secured by piles, had been placed at a proper point in the river, near the initial point, so as to have received and checked the first impingement of the strong current as it set across from the opposite shore, no further abrasion would have since occurred, either at that point, or upon the Iowa shore opposite the telegraph crossing. On the contrary, I believe, that the indentations previously made, would have been refilled by the formation of bars during the floods of 1867, and that the river would now be running substantially where it did before the flood of 1866.

So far as I am informed or have observed, there has been no material change in the banks of the river opposite the lower end of the depot grounds at Omaha during the past five or ten years. Bars have been formed in the river bed ; and the navigable low water channel has undoubtedly changed between the banks within that time, owing to the changes referred to in the river banks above.

If Omaha is to remain as the eastern terminus of the road; and the company intends to maintain and enjoy the use of the present depot grounds and shops at that place, it will certainly be for the interest of the citizens of Omaha, and the railroad company, to protect the banks of the river in that vicinity, without reference to any particular locality of the bridge. This protection will be just as important if the bridge is located at South Omaha, as it will be if located opposite the present depot grounds; and the cost whatever it may be, as stated in my former report, should certainly not be charged to the low bridge crossing.

I maintain furthermore, that so far as a proper protection of the river banks may be necessary to secure the permanency of the bridge foundations and structure, there will be no material difference in the expenditure required for the respective crossings proposed; and therefore, that no additional charge should be made on that account against the low bridge crossing, opposite the present depot grounds of the company.

The control and direction of the navigable channel during stages of very low water may, and probably will, be attended with some degree of difficulty and expense. The expedients to overcome these difficulties are various, and can only be decided upon fully when the precise nature and extent of the difficulty becomes apparent. At one time the aid of a small but powerful tug-boat may be all that is required. At another, it may be necessary to use a dredge for a short time; and again it may be necessary to sink one or more cribs, at proper points above the draw opening, that will give the current a permanent direction through them.

Years may, however, elapse before it may be found necessary to resort to any of these expedients. But suppose you provide for the contingency by appropriating and setting apart \$250,000 or \$500,000, or even \$1,000,000, and you still have a balance of ultimate expenditure in favor of this crossing sufficiently large, in connection with the net earnings of the bridge, to enable you to build a permanent high bridge at any other locality which may be deemed most expedient

hereafter. Whenever this time arrives, if it ever should, there is no doubt that the towns of Omaha and Council Bluffs will be very willing to take the low bridge off your hands at a fair valuation.

The liability of steamboats to accidents is no greater, if as great, in passing through a draw-bridge properly constructed, than in passing between the piers of a permanent bridge. These accidents always occur by reason of collisions with the piers or abutments, instead of the superstructure. And when the channel is kept open and well defined through either of the draw openings, the passage must be much safer and more easily accomplished, particularly in stages of very low water, than when the pilot is compelled to make an uncertain choice between several spans of a high bridge.

In stages of high water, and a strong current, I would consider the risks from accidents as being much less at the localities of South Omaha, and the Low bridge, where the direction of the river is comparatively straight for some distance above and below, than at the Childs' Mill crossing, where the current sweeps with great force around the bend in the river, and the boats coming up the river cannot see the piers until they get very near them.

Whatever may prove to be the effect, upon river navigation of constructing a bridge at any of the localities herein spoken of, it cannot be denied that there will be a much less number of boats to pass through a bridge at the proposed locality of the low bridge, than at any point further down the river, for the reason that by far the largest number of boats coming up the river, will not pass above the bridge, but turn about and pass down again. A few smaller-class boats will also probably do the same thing above the bridge, so that but few, comparatively speaking, will have occasion to use the draw.

I am fully aware of the opposition which will be arrayed against the project of building a low bridge, particularly at the locality herein indicated. Some will oppose it upon the grounds of impracticability, and upon the theory that nothing

can be done except what has been done. Others will oppose it from selfish or personal interests. Others will claim that it is too cheap and unpretending for a road of such grand proportions as the Union Pacific ; and that the government and people, therefore, will demand something more perfect, grand, and imposing, for the eastern terminus of the road. The citizens of Council Bluffs will oppose it because it will virtually establish the transfer grounds upon the opposite side of the river, and thus build up Omaha at the expense of Council Bluffs. The Legislature of Iowa, instigated by the citizens of Council Bluffs, will oppose it for the same reason, and *per contra*, the citizens of Omaha and the Legislature of Nebraska would favor it for the same considerations of self-interest.

I trust, however, that the company which furnishes the money to build the bridge ; and is to be held responsible for its permanency and success, will be allowed to have something to say in the matter.

I do not wish to be understood as having changed my views, as expressed in my former report, respecting the superiority of a high bridge over a low draw-bridge, in cases where the locality renders the construction of a high bridge reasonably practicable when viewed in connection with its present cost and previous expenditure, together with the more important and controlling interests of the company.

Whether this is such a case, the directors alone are competent to decide, after a careful consideration of the different views presented. They will bear in mind, however, that nearly all of our largest cities are approached from all directions by railroads having one or more draw-bridges to pass over ; and that nearly all of our largest rivers are spanned by one or more draw-bridges for the passage of railroads—all which would undoubtedly have been avoided if other and more controlling considerations had not rendered their construction expedient.

PLAN OF CONSTRUCTION.

I have very little to say upon this branch of the subject in addition to what was said in my former report.

If the bridge is to be regarded as a permanent one, the superstructure should undoubtedly be constructed of iron, upon the best plan now in use. My estimates for the low bridge have been based upon the plan of "Post's diagonal truss," which I consider equal, if not superior, to any other, as regards economy and strength. The draw-truss is entirely of wrought iron.

The foundations, under the water, should, unless rock is within easy reach, be of cast-iron cylindrical columns, sunk below the scour-line of the river; wooden piles cannot, probably, be sunk sufficiently low to ensure safety.

For a low bridge, I would not hesitate to carry the cast-iron columns up to the lower chord of the bridge, and rely upon them, in connection with a suitable ice-breaker, entirely for the support and protection of the structure.

But for a bridge fifty feet in the clear above high-water mark, although the columns, if of proper dimensions, would undoubtedly sustain the weight, I should have some fears as to their power, however well braced, to withstand the heavy pressure of the strong, deep current of the Missouri river at high floods, accompanied, as it must often be, with ice and flood-wood jams, and occasional shocks from rafts and steamers passing down the river. I think that, for a high bridge, solid stone-masonry of the very best quality will be required above low water, in order to guarantee the entire permanency of the structure.

Respectfully submitted.

SILAS SEYMOUR,
Consulting Engineer.

To the Honorable OLIVER AMES,
President Union Pacific Railroad Company.

LETTER OF J. L. WILLIAMS, ON THE LOCATION BETWEEN OMAHA CITY AND PLATTE VALLEY.

New York, January 2, 1865.

THOS. C. DURANT, Esq., V. President U. Pacific R. R. Co. :

Sir,—The consulting engineer, Col. Seymour, having submitted a report, dated 21st December, recommending a change of location, west from Omaha, I have prepared, at your request, and now submit the following statement of the question, in its engineering and commercial aspects, based mainly upon a personal examination of the present location, made in October last, in company with Col. Seymour, Mr. Henry, and Mr. Dey, the engineer in charge.

The facts bearing upon the question may be stated as follows :

1st. The way traffic eastward from the mountains, will consist chiefly of the product of the mines, most of which will be of little weight, in proportion to value. As respects the through traffic eastward, only such articles of ocean commerce as are of great value and little weight, and which therefore, can afford to pay land carriage, to save time and insurance, will be likely to come through by rail. On the other hand, the population of the extensive mining region of the mountains, will be chiefly supplied with provisions and breadstuffs, as well as with merchandise, heavy groceries and machinery, from the Missouri Valley. We may therefore assume the tonnage westward as at least twice as great as that going east. Until finished through to the Pacific, the difference will be far greater.

2nd. Present location between Omaha and the Platte Valley, at crossing of the Elkhorn, is twenty-three miles, with maximum grades, ascending westward, of 66 feet per mile, and ascending

eastward, 79 2-10 feet, or say 80 feet per mile, throwing off fractions.

3d. New route between same points, as suggested by consulting engineer, following down Mud Creek to the Pappillon, and thence up its western branch, is 32 miles long, with proposed maximum grades of 40 feet per mile in both directions. The curvature is assumed to offer equal resistance on either line.

4th. The extension of the line up the Platte, from the point of intersection at the Elkhorn, will have grades ascending with the general inclination of the valley, for 200, or perhaps, 400 miles, reaching a maximum at certain points, probably, of 10 feet per mile. As the same engine, upon this grade, will haul more than twice the load which it can bring from Omaha to the Elkhorn, even on the line of 40 feet grades, we may assume, that in the practical working of the road, whichever route be adopted, freight trains will be made up at this point, with the number of cars adapted to the grade east or west, as the case may be.

According to Col. Seymour's tables, a 30 ton engine will haul westward from the Elkhorn, on the 10 feet maximum grade, 56 loaded cars, or, in practice, say 50 cars, which will make a train quite long enough for convenient working. The cost of hauling these 50 cars over the high grades from Omaha, will be, comparatively, on the two lines, as follows :

An engine of 30 tons weight will haul over the 66 feet grades 16 cars, or over the 40 feet grades 25 cars. It will save fractional calculations, and is accurate enough for comparison, to assume three trains over the 66 feet grades, or 48 cars, as equal to two trains, or 50 cars, over the 40 feet grades. Then, supposing that the engine in each case, after delivering at the Elkhorn, the number of cars due to a Platte Valley train, goes west with its last section, without returning, it will have passed over the line of 66 feet grades, 23 miles in length, five times=115 miles run; or, over the line of 40 feet grades, 32 miles in length, three times=96 miles run. This, at \$1,00 per mile run of the engine, gives a cost of \$115 on the present location, for delivering at the Elkhorn 48 cars, and a cost of \$96 for delivering at the same point 50 cars by the proposed new route, by way of Mud Creek

and the Pappillon. The adoption of the longer line of 40 feet grades will, therefore, save \$19 in the cost of motive power on each 50 car loads, or, on each 500 tons of westward bound freight.

Eastward bound freight need not be brought into the calculation upon the foregoing basis. If I am right in assuming twice as much tonnage west and east, then the cars going east will be but half loaded. On the short route of 23 miles there are 80 feet maximum grades ascending eastward, over which the return engine could haul 13 loaded cars, making a gross load of 221 tons. But to equalize the cars going in both directions it must take 16 cars on each return trip. Half of these return cars, being empty, or all but half loaded, the gross load would be 192 tons. Upon this basis with the large preponderance of westward freight, the 80 feet grades, on the present location will in practice impose no extra cost, so far as respects the mere cost of motive power, over what is caused by the grades of 66 feet ascending in the direction of the greater traffic.

I have not deemed it necessary to enter into the question of passenger business. Until the new Territories are fully settled it will be heavier west than east. Passenger trains, as made up at Omaha, will run up the Platte, unbroken, and with the same engine to the first point of change, 80 or 100 miles distant. There would be a waste in the excess of power required east of the Elkhorn even with 40 feet, and still more with 80 feet grades, over what is required on the low grades west. The exact value of this waste is difficult to estimate. Ordinarily, the short line could be run in some 15 minutes less time than the new and longer route. But in the winter season the trip would often be made in less time over the longer route.

A saving of \$19 on each 500 tons of western bound freight would give, upon the yearly traffic, when it shall have reached 300,000 tons in that direction, an annual saving of \$11,400.

There would also be a material saving in wear and tear by adopting the more level route. Grades of 66 and 80 feet per mile are very destructive to machinery, and more so in the descent than the ascent.

On the other hand there is the expense of maintaining 9 miles

of cross-ties to be charged against the new line, equal to about \$2,000 per annum.

The cost of construction is considered equal—the expense of changing the first 5 or 6 miles from Omaha running down the River, to be done at a future day, to get a 40 feet grade throughout, off-setting the estimated saving west of the point of divergence.

It must also be stated, that the full advantage of the lower grade on the new route, will not be realized until the change alluded to in the last paragraph shall have been made. Without this change there is still near three miles of high grade, ascending westward from 61 to 66 feet per mile, to be overcome, mitigated somewhat in its inconvenience, by being at the beginning of the road, where assistant engines can at all times be in readiness.

While my statement of the question differs in form, and works out, perhaps, a smaller saving than that reached by the consulting Engineer, I concur with him in advising the change. For a business covering only the section of high grades between Omaha and the Elkhorn, it might be a nearly balanced question, whether to increase distance 40 per cent. for the proposed reduction of grades. But connected, as this section of the road is, with the 400 miles of 10 to 15 feet grade westward, this undulating section, with its grades of 66 and 80 feet, becomes a serious evil, affecting essentially the economical and beneficial working of this great national thoroughfare. And in view of the peculiar relation of this first section of the road to the whole line this side of the mountains, I go further than the consulting Engineer, as respects western ascents, and recommend that the Board limit its grades to 20 feet per mile ascending westward, and 40 feet per mile ascending eastward, maintaining still a lower maximum grade ascending west than east, equalizing, as near as may be, the power required to haul the outgoing and incoming trains, under the inequality of tonnage in the two directions, which, in all probability, will preponderate westward more largely than I have assumed. The Elkhorn Bluffs may require a 40 foot grade ascending eastward. But on the proposed route, by way of the Missouri, Mud Creek and Pappillon Valleys, a maximum ascending westward, as low as 20 feet, cannot materially enhance the cost of grading.

New York.—Chicago and Milwaukee 1st mort., 85; Morris and Essex 1st mort., 96¼; do., 2d mort., 86; Great Western 2d mort., 73; Peninsula R. R. 1st mort., 76; Chicago, Rock Island and Pacific 7s, 89¾; Marietta and Cincinnati 1st mort., 81¾; Galena and Chicago 1st mort., 98½; do., 2d mort., 98½; Chicago and Great Eastern 1st mort., 59; N. Y. and New Haven R. R., 118; do., bonds, 96; N. J. Central, 117; New Jersey R. R., 135; Stonington, 89; Sixth Avenue R. R., 120; N. Y. State 7s, Bounty Loan, coupon, 106; do., reg., 106½; do., 6s, 1872, ex-interest, 99; Ohio 6s, 1881, 102¾; do., 1875, 101; Virginia 6s, ex-coupon, 41; Brooklyn Water Loan, 95; do., Park Loan, 92; N. Y. City 5s, 1890, 88; American Coal, 54; Ashburton Coal, 10; Pennsylvania Coal, 150; U. S. Coal, 35¾; Wilkesbarre Coal, 39; Brunswick City Land Co., 8; Boston Water Power Co., 25½; South Am. Nav. and Marine R. R. Co., 115; Mariposa pref., 23½; Manhattan Gas, 160; Western Union Telegraph, 42; Adams' Exp., 61¼; Wells, Fargo & Co., Express, 67½; American Exp., 60; U. S. Express, 59; Merchants' Bank, 115; Bank of Commerce, 116; Fourth National Bank, 104½; Shoe and Leather Bank, 112; Continental Bank, 103; Hanover Bank, 110; Central National Bank, 110; Ocean Bank, 101; Phoenix Bank, 107; Bank of New York, 118; Bank State of New York, 108; Metropolitan Bank, 124; Importers' and Traders' Bank, 113; Atlantic and Pacific Gold, 2.25; Alamada Silver, 6.90; American Flag Gold, 1.05; Benton, 1.30; Columbian G. & S., 2.80; Consol. Gregory Gold, 12.00; Corydon, 6.80; Charter Oak Copper, 1.45; Crozier Gold, 0.10; Davidson Copper, 1.25; Des Moines, 1.00; Gunnell Union, 0.54; Hope Gold, 0.50; Hibbard G. and C., 1.00; Holman, 0.15; Keystone Silver, 0.06; La Crosse Gold, 0.55; Liberty, 0.07; New York Gold, 1.00; Nye, 0.06; People's G. & S., 1.35; Quartz Hill, 4.20; Russell File, 3.20; Smith and Parmalee, 6.10; Symond's Fork, 1.50; Tudor Lead, 3.25; United States, 3.85; Walkill Lead, 0.70; Central Petroleum, 0.80; United States, 4.00; Cherry Run Special, 0.15; Bennehoff Run Oil, 2.75.

Philadelphia.—Reading mort., 6s, 1844-'80, 91¼; Sunbury and Erie 7s, 98¼; Connecting R. R. bonds, 92¾; Camden and Atlantic R. R., 9; New Jersey 6s, 101; Harrisburg 6s, 90; Allegheny City 4½s, 59; West Chester R. R., 15; 13th and 15th streets, R. R., 21; Girard College R. R., 23; Germantown R. R., 28; Lombard St. R. R., 14½; Lehigh Coal and Nav. scrip, 51; Allegheny County coupons 5s, 88½; Camden and Amboy scrip, 74½; Lehigh Valley scrip, 16; Schuylkill Nav. Imp. Loan, 87; Morris Canal Boat Loan, 92; Locust Mt. Coal, 50; St. Nicholas Coal, 1½; New York and Middle Coal Fields, 35¾; Ocean Oil, 2½; Mt. Farm, 0.56; Caldwell, ¾; Mechanics' Bank, 34; Merchants' and Manuf. Bank, 60; Girard Bank, 57; Miners' Bank of Pottsville, 55; Manufacturers' Bank, 32½. The latest quotations are: City 6s, 97¼@97½; do., free of tax, 101¼@102; State 5s, 99@99¼; do., coupon, 94½@95; do., 6s, W. L., 102@102½; Phila., Wil. and Balt., 54¾; Reading 51@51; do., 6s, 1870, 96½@97; do., bonds, 91@91½; do., con., 103@103; Camden and Amboy, 131½@131¾; Penn. R. R., 56¾@56¾; do., 1st mort., 99¾@100; do., 2d mort., 97½@98½; Little Schuylkill R. R., 32@33; Morris Canal, 75@76; do., pref., 120½@120¾; do., bonds,

93½@94; Wyoming Valley Canal, 56¾@—; do., 6s, 85@87; Susquehanna Canal, 15@15¼; do., 6s, 65½@65½; Sch. Nav., 22@22¼; do., pref., 32@32¾; do., 6s, 1882, 78½@79; Union Canal bonds, 22¼@22½; Delaware Div. Canal, 55½@56; do., bonds, 85@89; Elmira and Williamsport, 30@32; do., pref., 40@45; do., 7s, 1873, 95½@97; do., 5s, 64½@67; Lehigh Coal and Navigation, 53¾@54; do., bonds, 1884, 90¾@91¼; North Pennsylvania, 34@36; do., 6s, 89½@90; Philadelphia and Erie, 28½@28¾; do., 6s, 91¾@92; Minehill, 56¾@57; Catawissa, 13@20; do., pref., 29½@30; Lehigh Valley, 61@61½; do., bonds, 95@96; Fifth and Sixth streets (horse), 40@43; Second and Third, 78@80½; West Philadelphia, 72@75; Spruce and Pine, 30@30¾; Green and Coates, 30@32; Chestnut and Walnut, 47½@48½; Thirteenth and Fifteenth, 20@21; Girard College, 28@30; Tenth and Eleventh, 65@67½; Union, 40½@41; Hestonville, 14¼@14¾.

Boston.—Boston, Hartford and Erie, 13¾; do., 7s, 44½; Vermont Central old, 1¾; do., 1st mort., 7s, consolidated, 68; Vermont Central and Vermont and Canada 8s, 103; Old Colony and Newport 6s, 1875, 96½; Western R. R. 6s, 1875, 99½; New Bedford and Taunton R. R. 6s, 1881, 97¾; Eastern R. R. 6s, 1874, 96; Central Pacific 1st mort. 7s, gold, 98¾; South Shore R. R. 6s, 94¾; Conn. and Pass. Rivers R. R. 6s, 95; Ogdensburg and Lake Champlain, 64¼; do., 1st mort., 99¾; Stony Brook R. R., 104; Sandusky, Dayton and Cincinnati old, 12; Granite Railway, 49; Adams Express, 56¾; Boston, Water Power Co., 25; Cary Imp. Co., 8¾; Essex Land, Co., 107; Opbir (N. S.) Gold, 2¾; Cook Co., Ills., 7s, 1880, 96¾; Massachusetts 5s, 1894, gold, 99; Rhode Island 6s, 1882, 100; Maine 6s, 1889, 100; New Hampshire 1884, 99½; Chicago 7s, 1881@1890, 99½; Boston 6s, 1874@1876, currency, 101; do., 5s, 1868, gold, 130@131½; do., 1875, 101¼; Portland 6s, 1871, 96¼; do., 1877, 95½; St. Louis 6s, 1886, 79¾; do., 1871, 80; do., 1887, 82; Boston Gas Light, 775; Boyleston National Bank, 136; Pawner's National Bank, 96¼; Traders National Bank, 100¼; North National Bank, 112; National Bank of Commerce, 118¾; Eliot National Bank, 116¾; Washington National Bank, 122; Everett National Bank, 102; National Bank of Redemption, 115½; Tremont National Bank, 123½; Market National Bank, 110¼; do., Brighton, 111½; Merchants' National Bank, 112; Mt. Vernon Bank, 106; State National Bank, 80¼; Blackstone National Bank, 127; Allouez Mining Co., 6; Boston, 50c.; Bay State, 8¼; Concord, 3; Canada, 62c.; Dana, 1¾; Hancock, 8¾; Hanover, 1½; Humbolt, 1¾; Hungarian, 1; Native, 2; Phoenix, 5; St. Clair, 5¾; Superior, 3½; Toltec, 1½.

Baltimore.—Western Maryland bonds guaranteed, 93½; do., 2d mort., 64; Marietta and Cincinnati 1st mort., 82; Virginia 6s, reg., 38; do., coupon, 37½; Bare Hill, Mining Co., 0.30; Baltimore Gas Co., 200; Bankers' and Brokers' Telegraph, 0.50; Franklin Bank, 13½; Third National Bank, 102; Farmers' and Planters' Bank, 29½; Mechanics' Bank, 9; National Exchange Bank, 97¾; Farmers' and Merchants' Bank, 45½; Union Bank, 60. The latest quotations are: Balt. and Ohio, 116@117; do., 6s, 1867, 98@100¾; do., 1875, 97@97¼; do., 1880, 97@97½; do., 1885, 99@99½; Northern Central,

45½@46½; do., bonds, 1885, 82@92¼; N. W. Va., 18@18¼; do., 1st mort., 1873, 93½@93½; do., 2d mort., 90@93; do., 3d mort., 89@91; do., unguaranteed, 17@17; Marietta and Cincinnati 7s, 1891, 82@82¾; Central Ohio, 26@29; do., 1st mort., 89@90; Western Md. bonds, 64@68; do., guar., 93½@94½; Maryland 6s, coupon, 1870, 101@102½; do., Ins., 101@102; do., 1890, 101½@102¼; Baltimore 6s, 1870, 97@97¼; do., 1873, 96@99; do., 1875, 99@99; do., 1886, 98@98¼; do., 1890, 97@98; do., coupon, 100@100; do., Park, 98½@99; do., 1892, 95@95; do., 5s, 1838, -70, 83@83; City Passenger R. R., 18@18; Canton Co., 45@46¼; Gardner, 0.80@0.85; Am. Gas Coal, 0.50@0.95; Maryland Anthracite Coal, 5@7; George's Creek, 95@101; Santa Clara, 2@4; Balt. Chrome, 0.20@0.25; Bare Hill, 0.25@0.25; Atlantic Coal, 0.60@0.70; Mineral Hill, 0.10@0.40; Baltimore Coal, 160@170.

Bridge over the Ohio at Louisville.

Proposals will be received by the "Louisville Bridge Co.," A. Fink, Esq., Chief Engineer, until the 10th of April, for the construction of about 22,000 yards of the masonry of the bridge over the Ohio River at Louisville. Plans and specifications are now ready for inspection. We are glad to see that this enterprise, so fraught with interest to the city of Louisville, is about to be commenced and pushed forward with energy. We understand that already \$1,000,000 has been subscribed for the completion of this great work, which will unite Louisville with the North and East, and give her connection with all the great marts of America, without the delay and expense of crossing the river by means of the ferry.

The Advertisement of the "THIRD NATIONAL BANK," of which J. F. D. LANIER, Esq., is President, and PARKER HANDY, Esq., Vice President, will be found on our outside page. This Bank is the designated Depository of the United States, and authorized agent of the Treasury.

We invite attention to the Advertisements of Messrs. HOY, KENNEDY & Co., in another column. These gentlemen are importers of Railroad Iron and Dealers in Railroad Supplies. Agents for Owen's Patent Wheel, Tire and Axle Co., also for the Earl of Dudley's Iron. Office and Warehouse 111 Liberty street, New York.

Pacific Railroad Surveys.

We have received from Hon. Jesse L. Williams, Government Director of the Union Pacific Railroad, an official copy of his report on the surveys over the Rocky Mountains—showing the advantages and disadvantages of the different routes—supplied, with the consent of the Secretary of the Interior, in advance of its publication by the Department. As these engineering facts respecting this hitherto unexplored region are of interest to railroad men, and especially to engineers, we have concluded to publish it entire. Mr. Williams says:

The preliminary surveys across the first range of the Rocky Mountains being nearly completed the Government Directors deemed it important that one of their number should personally examine such of the lines as appeared most feasible. Accordingly, at the request of my colleagues, and by invitation of Colonel S. Seymour, the Consulting Engineer of the company, I accompanied him to the mountains in September last.

At Omaha we were joined by General G. M. Dodge, Chief Engineer, and in passing over the several routes, were further aided by explanations, on the ground, by the Division Engineer, under whose immediate direction the survey had in each

case been made, with the advantage also of the maps and profiles. Under the requisitions of the thirteenth section of the act of Congress, approved July 2, 1864, I respectfully submit, for the information of the Secretary of the Interior, the following general results, premising that this report has been submitted to my colleagues and sanctioned by them:

This first mountain barrier, as it stretches north and south across the general course of the road, between the 105th and 106th meridian of longitude, may be described as extending from the canon of the South Platte, near the latitude of Pike's Peak, to the North Platte, a distance of near three hundred miles. Its more southerly and higher portion, called the Snowy Range or Rocky Mountains proper, forms part of the great divide of the Continent, separating the waters of the Platte from those flowing into the Colorado of the West. The northern section of this mountain barrier, being a part of the subordinate range known as the Black Hills, and only dividing the drainage of the two forks of the Platte, is, nevertheless, as to direction, the continuation of the main Rocky Mountain range northward, possessing the same mountain characteristics, though having less altitude and gentler slopes. The Cache-la Poudre River, the largest tributary of the South Platte, taking its rise in its most southerly branch, near the heights of Long's Peak, marks the point of division of the range into the two sections here described. The water shed of the Continent diverges here to the northwest forming first the southwestern boundary of the North Park, and thence continuing northwest, sinks into the depression known as Bridger's Pass, where it is 7,534 feet above the bed of the sea, and 3,892 feet lower than at Berthoud Pass in the snowy range west of Denver.

Up to the eastern base of this north and south mountain range, the broad and generally smooth plain of the Platte Valley opens favorable approaches, through its several tributaries, to any mountain crossing that may be selected. The point of crossing the mountain is, therefore, the first problem to be solved.

In the wide range of these surveys, continued now through three years, ten distinct points of crossing have been examined. They have been run with level and transit, in all cases affording reasonable hope of practicability; or, where less promising, they have been explored with care, availing, in such cases, of barometrical observations. The passes thus examined include, as I understand, all that have been suggested by mountaineers or others familiar with the country as possibly feasible. Enumerating from south to north, they may be briefly described as follows:

ROUTE NO. 1. OVER HOOSIER PASS AT HEAD OF THE SOUTH PLATTE.

Mr. F. M. Case, civil engineer, reports to the Vice President, Dec 15, 1864, that he made a survey of the governing sections of this route and submits profiles, first, of the mountain range at Hoosier Pass; secondly, of a line eighteen miles northwestward down Blue River, a tributary of the Colorado; and, thirdly, of a line run forty-eight miles southwestward from the pass, down the upper portion of the South Platte, through the South Park to the head of the Platte Canon. From the head of this canon, as he reports, the line would follow the river northwestward some forty miles through the mountains to the plains with, as estimated, an average descent of seventy feet per mile. Of this distance the engineer estimates that twenty miles would be close canon, both walls being washed by the stream, and the direction so circuitous as to require considerable tunnelling. His estimate of the height of this pass above the sea, from barometrical observations in the vicinity, is 11,500 feet. A tunnel two and a half miles through granite is required; grade line of tunnel upon the assumed level, 10,660 feet above the sea. The general alignment of this route is so unfavorable, considering Salt Lake as the point aimed at, as, in the judgment of the engineer, to render a more extended survey needless—145

miles of road being required between Denver and the mouth of the Blue River, only seventy-six miles west of the meridian of the former place.

ROUTE NO. 2, OVER TARRYALL PASS,

This route, it seems, did not so commend itself to the engineer as to require a survey. He estimates the pass to have about the same altitude as Hoosier Pass—11,500 feet above the sea. The approach to it from the plains on the east would be, first, through the canon of the South Platte for some twenty-five miles, and thence up Tarryall Creek, a branch of the Platte, to its source in the range a few miles northeast of Hoosier Pass. From the west the approach would be from the valley of the Blue River, above Breckinridge, through the Indiana Gulch. While the engineer does not assume to speak of this route advisedly he thinks the summit could not be reached from the east without exceeding the maximum grade of 116 feet per mile, and that the descent of the gulch on the west 150 to 200 feet per mile. Having made no definite survey he does not give the length of the tunnel.

ROUTE NO. 3, THROUGH THE NORTH FORK OF SOUTH PLATTE.

As in the case last described Mr. Case deemed a critical survey of this route unnecessary. He says in his report that it would enter the mountains at the mouth of the South Platte Canon, being thus coincident with the last two named lines for ten miles, and thence up the north fork of the Platte thirty-five miles, crossing the range still further north than the route last described, and connecting on the west with one of the head branches of Snake River, an affluent of Blue River. This pass was represented to the engineer, by a reliable explorer, as being a little below the line of Arborecena or "Timber line," and was assumed as about 11,500 feet above the sea. Upon this hypothesis, and with the aid of barometrical observations in the vicinity, the engineer estimates that on the eastern approach to the summit, some 2,300 feet elevation must be overcome in twelve or fifteen miles, and on the western approach 2,700 in twenty miles. How far this could be alleviated by a tunnel, and what would be the length of the tunnel is not stated. The entire route from the plains on the east to the valley of the Blue River on the west, is reported as running through a narrow mountain valley, in many places tortuous.

It will be noticed that the two routes last described, entering the mountain as they do, far to the south, through the canon of the South Platte, are, like route No. 1, forced out of the proper direction.

ROUTE NO. 4, OVER BERTHOUD PASS.

From the beginning of these investigations this route has attracted much interest, as well from the general belief of mountaineers, that it was the most favorable pass through the Snowy Range, as from its locality, being in the direct course from Denver to Salt Lake City, the two chief points on the route, both of which it seemed desirable to pass. In the summer of 1862, prior to the first meeting of the corporators of the Union Pacific Railroad for the purpose of organization, Mr. F. M. Case, at the instance, and, I believe, at the expense of the friends of the work in Colorado, made what he called an instrumental reconnaissance of the route. His report, addressed to Hon. John Evans, then Governor of Colorado Territory, was embodied in his subsequent official report of December 15, 1864. Subsequently, in 1866, by direction of this Board, a second and more careful survey of this route was made by Mr. P. T. Brown one of their engineers. In the general topographical facts, the two surveys agree. I passed over this line as far as the summit of the range accompanied by Colonel Seymour and Mr. Brown.

The line from the South Platte at Denver to the summit of Berthoud Pass is sixty miles in length. The survey was extended west into the Middle Park, seventy-eight miles from Denver, in the direction of Salt Lake. For general description it naturally divides as follows:

1 Denver to Golden City, fourteen and a half

miles. This is over a rolling and rapidly rising plain, falling into Clear Creek Valley, six miles east of the mountain, and meeting the foot of the range twelve miles from Denver. Ruling grade, 116 feet per mile, of which there is about three miles. Construction not very expensive.

2 Golden City to upper end of Clear Creek Canon 15 $\frac{3}{4}$ miles. Golden City is at the transition point from the sedimentary to the granite formation. Here the line enters Clear Creek Canon, which extends 15 $\frac{3}{4}$ miles, rising in this distance 1,544 feet. Through a portion of the Canon the valley rises faster than the maximum grade, but with careful location and heavy cost, Mr. Brown thinks the grade need not exceed 116 feet per mile at any point. Two-thirds of the distance will be curved, much of it sharp. The greater part of the distance may be called close canon, and a part narrow open canon, with abrupt slopes.

3 From head of canon to east end of Berthoud Tunnel, 28 $\frac{1}{2}$ miles, the line follows the narrow mountain valley of Clear Creek, through the midst of the gold mining developments, passing many quartz mills. Ruling grade, 116 feet per mile of which there will be about 13 miles. For seven or eight miles of the upper portion the fall of the valley greatly exceeds the maximum grade, reaching in places over 300 feet per mile. Using the maximum grade of 116 feet per mile from the tunnel eastward the line is necessarily thrown on the steep, rocky, and in places, precipitous mountain sides, at an elevation of 100 to 400 feet above the creek involving, of course, very heavy cost. In the whole distance from the base of the mountain to the tunnel, Clear Creek, as Mr. Brown supposes, would be bridged perhaps twenty times, with probably two or three miles of tunnelling through sharp points. To give greater length of line, for the purpose of reducing the grade to the maximum prescribed by law, the surveyed route, in ascending, turns up South Clear Creek for two and one-half miles, thence by a short tunnel through a ridge into Bard's Creek Valley, which it follows down, reaching the main valley at Empire City.

4 Berthoud Tunnel would be 3 1-10 miles long, and pierces the mountain 1,364 feet below the summit of the pass. The material to be excavated, the common granite of the mountain. Grade line of tunnel at highest point, 10,000 feet, and summit of pass, 11,426 feet above the sea.

5. West end of tunnel to end of survey, 16 $\frac{1}{2}$ miles. Descending westward, the slope of the mountain is followed, for some distance until the valley of Moses' Creek is reached, which is a tributary of the Colorado, and thence with this valley to the Middle Park. Ruling grade, 116 feet per mile for first 11 $\frac{1}{2}$ miles. I did not pass over this portion of the route.

ROUTE NO. 5, OVER BOULDER PASS.

While standing on the mountain peaks near Berthoud Pass, on the 18th of September, in the clear mountain atmosphere, I had a full view of the Boulder Pass, twelve miles further north. From its apparent height above the growth of timber, and from barometrical observations before reported, I was fully convinced of its impracticability; yet, in deference to the views of gentlemen having mining interests on the Boulder, I fully intended visiting that pass. But a fall of eight inches of snow on the 19th, on the eastern slope, which I learned was two feet deep at the western base of the range, defeated this purpose. A few weeks later Mr. Brown made a survey of the Boulder Route. The Chief Engineer reports the results as follows: First, that the pass is 11,700 feet above the sea; second, a tunnel of six miles required; third, the approach is through either South Boulder or Middle Boulder Creek, on either of which the ascent is too rapid for the maximum grade; and, fourth, that on either of these streams expensive canons are encountered.

ROUTE NO. 6 UP THE CACHE-LA-POUDRE AND DALE CREEK AND OVER ANTELOPE PASS.

During the last week in September I made a reconnaissance on horseback over this route, from the eastern base of the mountain, at Laporte, to

the western base in the Laramie Plains, at the common point of junction with the Lodge Pole and Crow Creek route, in company with the Chief Engineer, the Consulting Engineer, and Mr. James A. Evans, Division Engineer, whose three years' service in directing these experimental surveys has made him familiar with the topography of this range.

Antelope Pass is a depression in the ridge separating the waters flowing into the Laramie River on the west, and those of Dale Creek, a tributary of the South Platte. Dale Creek, taking its rise near Cheyenne Pass, runs in its upper section on the western slope of the range, cutting the main range of the Black Hills in its southeasterly course, and joins the Cache-la-Poudre River some three miles above the eastern base of the mountain. Through the Dale Creek Valley a favorable route is found from the Cache-la-Poudre, near Laporte, to Laramie Plains, in a northwestern direction, finding its summit not in the main Black Hill Range, but in the subordinate divide between Dale Creek and Laramie River. This ridge or divide is crossed at Antelope Pass, which has 195 feet less elevation than the main range at Evans' Pass, in the direction of Crow Creek and the Lodge Pole.

The opening thus cut through the mountain range by Dale Creek, and which has heretofore been used as the Overland Stage Route, the railroad survey now occupies. The main features of this line are these: Total length of mountain section, from eastern to western base, $39\frac{1}{4}$ miles, of which 33 miles is in the ascent of the eastern slope, and $6\frac{1}{2}$ miles on the western slope. The western slope, and also the first $7\frac{1}{2}$ miles of the eastern ascent from the Plains, following up Pitchfork Creek, is chiefly in the secondary formation, and presents a comparatively favorable profile. On these two sections the line may be located, with a maximum grade of from 85 to 90 feet, without expensive work. The intermediate section of 25 miles, all in the Valley of Dale Creek, and in the granite formation, presents some expensive grading, especially near the crossing of Dale Creek, and also near the canon of Stonewall Creek, where the line of transition between the stratified and granite formations is crossed. Three bridges of some magnitude are required on this division, the chief of which is over Dale Creek, near four hundred feet long. The deepest part of the narrow chasm here to be bridged is 108 feet below grade line. As the line now runs the maximum grade occurs frequently, with occasional undulations by which ascent is lost. With the time and care needful on a final location, the ruling grade may be reduced below the limit allowed by law, and probably to 105 or 110 feet per mile, and the undulations chiefly, if not altogether avoided. The grade line at Antelope Pass, without a tunnel, and with a cut of moderate depth, is 8,045 feet above the sea.

The approach to this passage of the Black Hills up the Valley of the South Platte to the mouth of the Cache-la-Poudre River, and thence up that valley to Pitchfork Creek, some eight miles below Laporte, which latter tributary is followed to the entrance of the Black Hills. The whole route east of the mountain is of the most favorable character, permitting a grade uniformly ascending with the rise of the valley.

ROUTE NO. 7 FOLLOWING THE DIVIDE BETWEEN CROW CREEK AND LONE TREE CREEK TO EVANS' PASS.

Returning eastward from Fort John Buford, (now Fort Sanders,) on the Laramie River, to which point our party had extended their reconnaissance, in part to obtain a military escort, which General Dodge deemed a prudent precaution against Indian depredations on the Lodge Pole, we crossed the Black Hills by the new Lone Tree and Crow Creek divide route, which we followed to a point near the traveled road from Denver to Fort Laramie, and thence to Laporte, along or near the eastern base of the range.

As the route last described finds an easy ascent of the mountain, through the valley of Dale Creek,

so this route, by following the smooth and gently ascending ridge dividing the drainage into Crow Creek on the north, and Lone Tree Creek on the south, which ridge extends far out into the plains, occupies a favorable locality for crossing the Black Hills, more exempt from obstructions by snow drift than ordinary line. This ridge can be approached from the valley of Crow Creek through a small east and west tributary rising at the rate of from thirty to sixty feet per mile. Reaching the divide seven miles east of what appears to be the general course of the base of the range, the line pursues it for twenty miles to the summit of the Black Hills at Evans' Pass. For the first seven miles this divide presents a smooth profile. Entering a little west of this the granite formation, the next five miles present a rough profile, on which the work will be heavy and the material in great part rock. The next eight miles to the Pass are generally on the summit, or on the adjoining slopes of the divide, with a favorable profile and alignment, and comparatively light work. Where excavation is required to any considerable depth on any part of the mountain, it will be rock. The experimental line up this eastern slope of the mountain is laid with a ruling gradient of 106 feet per mile. But the Chief Engineer is confident that this can be reduced, on the final location, to the maximum of 90 feet per mile, which is less than the grade of the Pennsylvania Central road, in the ascent from Altoona to the tunnel, with curvature very much easier than is there introduced.

The summit of the mountain presents here a broad and gently rounded surface, admitting of no reduction by any judicious tunneling. With an open cut of moderate depth through rock, the grade line is 8,242 feet above the sea.

Descending westward the prospect is less favorable. Dale Creek, heading a few miles north, near Cheyenne Pass, has worn a valley in the western slope, which can be crossed only by an embankment and bridge of considerable height. And, after reaching the secondary summit between this creek and the Laramie Plains, the descent thence to the common point of junction with the line over Antelope Pass at western base of mountain, is here more abrupt than on that route. A careful re-survey of this western slope, $10\frac{1}{4}$ miles distance, is proposed by the Chief Engineer, under the belief that he can, within reasonable limits of cost, establish a ruling grade not exceeding ninety feet per mile, as on the eastern slope, and at the same time, avoid any depression of grade in the intermediate valley below the summit west of Dale Creek. So important is it that in these mountain ascents, elevation once attained, be not lost by injudicious undulations, that I have not failed, as a member of the Committee on Location, to urge this view.

To reach this crossing of the Black Hills, the line would leave the South Platte at Julesburg, following up the valley of Lodge Pole Creek, 106 miles, and thence bearing a little southward, through a southwestern tributary, cross the divide to Crow Creek Valley.

ROUTE NO. 8, VIA LODGE POLE, CAMP WALBACH AND CROW CREEK.

This route, like the Cheyenne Pass line, finds its approach to the Black Hills through the Lodge Pole Valley to Camp Walbach, at the base of the range, and its route thence up the mountain slope is coincident with the Cheyenne Pass line to the crossing of Lodge Pole Creek. Thence diverging to the south, it pursues generally the divide between the drainage to Lodge Pole on the north, and Crow Creek on the south. It crosses the summit of the range at Evans' Pass, there intersecting Route No. 7, and having, of course, the same gradient, to wit, 8,242 feet above the sea. But before reaching this pass, in traversing the uneven surface on the mountain tributaries of Crow Creek, this line encounters a higher country, over which the gradient reaches the height of 8,400 feet above the sea. The descent of the western slope is coincident with Route No. 7.

Previous to the surveys of 1866 this was considered the shortest practicable route over the Black

Hills, and it is the route compared with the Cache-la-Poudre line in the report which I had the honor to make to the Department, dated 28th February last. But the investigations of the last season, under the direction of General Dodge, Chief Engineer, whose knowledge of this region, acquired during his command of this Military Department, has been of great service to the company, have resulted in the discovery of Route No. 7, which by leaving the Lodge Pole far out in the plains, finds a more direct alignment, and in all respects a better line.

ROUTE NO. 9, VIA LODGE POLE CREEK AND CHEYENNE PASS.

The Cheyenne Pass over the Black Hills, in connection with the Lodge Pole Valley as its eastern approach, has long been a thoroughfare for travel, and was thus from the beginning brought prominently to the notice of those seeking a route for the Pacific Railroad. In the fall of 1863 a line of levels was run over this pass by Mr. B. B. Brayton, Engineer. Again, in the summer of 1864, a more careful survey was made by Mr. James A. Evans. The general results of Mr. Evans' survey are: First, that the summit of the pass is 8,656 feet above the sea; second, that a tunnel, 1,500 feet long, through granite, on a grade line 8,540 feet above the sea, would be required; third, that this tunnel could be reached from the east by way of Camp Walbach, with a maximum grade probably not exceeding 116 feet per mile; and, fourth, that on the western slope of the mountain the ruling grade could not be reduced below 132 feet per mile, unless by the objectionable expedient of increasing the length of the line by switching back.

ROUTE NO. 10—THROUGH LARAMIE CANON.

Knowing that this stream had cut its channel deep through the Black Hill Range, thus presenting by its immediate valley a more uniform ascent, and a total rise and fall between the Platte Valley and the Laramie Plains, materially less than by other routes crossing over the range, and further, that this route would occupy a good general direction, the character of its great canon has been an object of interest from the first. In 1864 Mr. Evans commenced the examination, but accomplished it only on the lower portion. In 1865 Mr. Case explored without instruments the upper portion. But until Mr. Evans, in his second attempt, in 1866, succeeded in running a line entirely through this canon, it is not probable that any human being, savage or civilized, ever passed through the whole length of this deep and rugged gorge. Its direct length is 14 miles; its length by the survey, 25 miles; its course in many places, very tortuous, and its vertical walls of rock from 500 to 1,500 feet in height. The fall of the stream in places is from 150 to 200 feet per mile, and its current, of course, extremely rapid. The Chief Engineer reports it as wholly impracticable for railway purposes.

The route up the North Platte and through the South Pass has been followed by the travel from the earliest beginning of emigration across the Continent. The North Platte, like the Laramie, but with a still larger flood, has worn its channel through the range, presenting unquestionably, if it could be followed, an easier and more uniform grade from the plains to the divide of the Continent at the South Pass than any other route. Its greater length, however, caused by its northern circuit, its wider divergence from the important mining resources of Colorado, in which the nation has an interest, with the apprehension of deeper snows in the region drained by the Sweet Water, precipitated there through the directing influence of the Wind River mountain range, seem to have outweighed, in the judgment of the company and their engineers, any supposed advantage in grades. The survey of this route, though commenced in 1865, near Fort Bridger, and extended eastward through the South Pass and a short distance down the Sweet Water, by Mr. S. B. Reed, one of the company's engineers, was not continued through the Black Hills. The engineers, from their reconnaissance and information from others, report

narrow defiles and canons where the North Fork cuts the mountain range, so formidable as probably to force the line out of the valley and over mountain spurs. But the length of this difficult construction, as also the exact comparative length of the North Platte route, is unknown. The water shed at the South Pass is 7,470 feet above the sea. It is sixty-four feet lower than the same dividing ridge of the Continent at Bridger's Pass, one hundred miles to the southeast, and 4,000 feet lower than the Berthoud Pass, west of Denver.

COMPARISON OF ROUTES.

Grouping the ten routes thus briefly described into two classes, five of them cross the Snowy range, and five the Black Hill range.

Of those in the Snowy range, examinations indicate the Berthoud Pass, designated No. 4, as having most of the elements of a feasible line.

Contrasting the Berthoud Pass line with either of the two available lines over the Black Hills, the Lone Tree and Crow Creek line, over Evans' Pass, designated as Route No. 7, or the Cache-la-Poudre line No. 6, the comparison is greatly against the Berthoud, as follows:

8. At Berthoud Pass the gradient is 10,100 feet above the sea; at Evans Pass, 8,242 feet.* Difference in the elevation to be overcome with the commerce of the country, 1,858 feet.

2. Tunnel at Berthoud Pass, three and one-tenth miles long. As the summit of the pass is 1,300 feet above the level of the tunnel, the material excavated would be chiefly passed out at the ends. Under these circumstances not less than three or four years, certainly, would be required for its construction, within which time, it is confidently believed, the track layers from Omaha, by a more favorable route, may meet those from Sacramento on the plains of the Humboldt River. No estimate has been made of its cost. Unquestionably the outlay of capital would be greater than is warranted at a single point, be it from national or individual means, when the same capital and labor would stretch out the road so far toward the Pacific, over the cheaper routes that offer. At either of the two Black Hill Passes no tunnelling is required.

3. Besides Berthoud Tunnel, there would be fifteen miles in the Clear Creek Canon, and ten miles in the upper section of Clear Creek, which would cost, perhaps, beyond all precedent in this country. Contrasting the aggregate of the tunnel and this twenty-five miles with same length of mountain work, on the Lone Tree and Crow Creek divide route over the Black Hills, and the difference would grade 100, perhaps 150 miles of average line between the Black Hills and Salt Lake.

This comparison, thus stated, in very general terms, is confined to the first mountain range, as if beyond that the extension of the two routes to Salt Lake were alike feasible. Such, however, seems not to be the case.

In June, 1865, Mr. Reed, under instructions from T. C. Durant, Esq., Vice President, and with a view to a line across the intermediate Green River Basin, made an extended reconnoissance of the country east of Utah Lake, to find, if possible a practicable route over the Wahsatch Mountains to Green River *via* Spanish Fork and the Uintah River. His report, dated April, 1866, represents that there is no route practicable for a railway from Utah Lake eastward to Green River, through the Uintah Valley. We have seen that the eastern rim of the Green River basin cannot be crossed

without an expense and delay quite too great. And if the Snowy Range could be crossed, the Chief Engineer expresses the belief that two subordinate north and south ranges would interpose further west.

The basin of the Green River, and especially its main valley, the White River, running from east to west, near the 40th parallel, has been represented as much more favorable to agriculture, with better supply of timber, than the country along the Bridger Pass route. Having less altitude by some two thousand feet, and lying two degrees further south, this claim is no doubt just, and it is to be regretted that access for the railroad seems forbidden by the great height of the mountains forming its eastern and western boundaries.

But were this route practicable, yet in the aspect of gradients, it would be less favorable than the Bridger Pass route, the mountain ranges being higher, and the intermediate valley lower. Green River, where this line would cross it, must be near 2,000 feet lower than on the Bridger Pass route, while the Snowy Range is, over the Berthoud Pass, 2,000 feet higher than the Black Hills, making a total difference of some 4,000 feet in the ascent to be overcome between Green River and the summit of this most easterly mountain range.

In whatever aspect this important question may be viewed, whether in the detail of actual surveys and levelling, or in a general grasp of the leading features of this part of the Continent, there can be no question that the Union Pacific Railroad Company, in deciding to locate over the Black Hills and through Bridger's Pass, have but conformed to the topographical shaping of the region to be traversed by the road.

Though the topography of this mountain region forbids the passage of this national thoroughfare directly through the mining region of Colorado, yet the transverse valleys favor a connection by branch. The interests of the company of Colorado and of the Nation, seems alike to demand such connection. Adopting the Cache-la-Poudre route, the proposed branch, as already surveyed, along the South Platte to Denver, would be fifty-three miles long; or by the Lodge Pole, the branch would be lengthened to 112 miles, but the main line shortened thirty-seven miles. The paramount claims of through commerce seemed to the Board to give preponderance, in the aspect of commercial considerations, to the short main line.

Journal of Railroad Law.

LIABILITY OF RAILROAD COMPANY FOR BAGGAGE OF PASSENGER BURNT IN DEPOT.

The case of *Roth vs. The Buffalo and State Line Railroad* lately decided by the Court of Appeals is important in deciding that common carriers of passengers, with their ordinary baggage, for hire, are liable for losses occurring from any accident to the baggage while it is in their keeping as carriers, except those arising from the act of God or public enemies.

This strict accountability as carriers terminates within a reasonable time after the arrival of the baggage at the place of destination where the carrier is ready to deliver the same to the passenger according to the terms of the contract.

Where the passenger did not call for his trunk, but left it in the hands of the company overnight, without any arrangement with them, and the same was destroyed by the burning of the depot before morning, held, that the company were not liable.

SMITH, J.—All extraneous circumstances stated by the witnesses being rejected, the case proved is briefly this: Dunn, the plaintiff's assignor, took passage, with his trunk, at Dunkirk, for Buffalo, on the defendants' cars. Immediately on the arrival of the cars at the place of destination, he went from the depot without looking for his trunk, or saying anything about it to the defend-

ants' agents, and left it in their hands, as he himself testified, solely for his own accommodation. The agents of the company immediately proceeded to unload the baggage on the train, and without any unnecessary delay were ready to deliver it, and did deliver all that was called for at the platform by persons having checks. They carefully stored what remained, and during the night the depot and portions of the baggage were consumed by fire, without fault on the part of the defendants, and doubtless Dunn's trunk was among the baggage thus destroyed.

The irregularity of the trains and the consequent accumulation of baggage at the Buffalo station, the lateness of the hour and the state of the weather, the fact that Dunn's wife was under his charge, and that he saw no carriage at the door from which he made his exit, are circumstances of no moment. Since it is not shown that they rendered it unsafe or improper for him to receive his trunk on its arrival, and besides it distinctly appears that they did not influence his conduct. According to his own statements he left his trunk at the depot over night because "it was on his route the next morning."

What his route the next morning was, does not appear, and it is not important, for the fact is undisputed that he had reached the termination of his route on the road of the defendants, and their contract to transport him and his baggage was fully performed.

It is well settled in this State, that common carriers of passengers, with their ordinary baggage, for hire, are liable for losses occurring from any accident to the baggage while it is in their keeping as carriers, except those arising from the act of God or a public enemy. (*Hollister vs. Nowlen*, 19 Wend., 234; *Cole vs. Goodwin*, id., 251; *Powell vs. Myers*, 26 id., 591. This liability, once commenced, does not necessarily terminate with the transit, but *prima facie* continues until safe delivery of the baggage to its owner. (Id.) The case of *Powell vs. Myers* above cited, decided by the court for the correction of Errors, shows the extent to which these salutary rules have been enforced. There a passenger on a steamboat on the Hudson river, from West Point to New York, left the boat on its arrival at New York, at about ten o'clock; the owner leaving his trunk on board with the consent of the captain, and upon his assurance that it would be safe during the night. The next morning about eight o'clock the owner inquired for his trunk, and learned that it had been delivered to a negro on a forged order, the master of the boat pointing it out to him. The carrier was held liable.

But in that case Senator Verplanck remarked: "There may unquestionably be cases where, at some time after the arrival at the place of destination, the strict responsibility of the carrier, as such, for goods or baggage remaining in his possession undelivered, without fault or neglect of his own, should cease and he would then continue to hold them, not as a carrier, insuring against all except public and inevitable perils, but a mere bailee in deposit, gratuitously or otherwise, according to circumstances. Such a termination of the carrier's responsibility and change of character of the deposit would be regulated by usage, the course of business, sometimes by legal principles applied to the special facts, the acts of par-

* A better comparative view of these mountain altitudes will be obtained by stating here the height of other well known points on the Continent above the sea, as follows: Lake Michigan, 578 feet; the Mississippi, at St. Louis, (high water), 452 feet; the Missouri, at Omaha, 968 feet; South Platte at Denver, 5,300 feet; general level of the Plains at eastern base of Rocky Mountains, about 5,000 feet; Salt Lake City, 4,286 feet. The grade line of Central Pacific Railroad on the summit of Sierra Nevada range, in California, is 7,042 feet, and that of the Pennsylvania Railroad on the summit of the Allegheny Mountains, 2,160 feet, above the sea level.

While the principle of Col. Seymour's report, to wit, an increased length of about nine miles for a reduction of grades to 40 feet throughout, may be safely adopted, yet the actual change of this location should await the more careful surveys of the new route now in progress, that the correctness of his basis may be verified.

It should be stated that the survey of the line by which the high grade at Omaha is hereafter to be avoided, has not yet been made, nor have I passed over the ground. For the first three or four miles following the Missouri bottom, there can be nothing to prevent a grade of 20 feet. Should the narrow ridge between the river bottom and the parallel valley of Mud Creek prove too high to pass by a thorough cut, the Company, when its means shall warrant, can well afford a short tunnel rather than a continued use of the three miles of 61 to 66 feet grade.

The commerce of the country, in seeking its destination through the broad and level valley of the Platte, so favorable as an inlet to the great mining region, and as a through route to the Pacific, should not be compelled to pass over the narrow belt of high undulating land, separating the Missouri valley from the Elkhorn, encountering in this short distance a total rise and fall of over one thousand feet.

The further general remark may be made, in conclusion, that the undulating character of the country approaching the Missouri river, on both sides, forces railroad lines into the valleys, even though considerably lengthened thereby.

Very respectfully,

J. L. WILLIAMS,

Member of Locating Committee.

LC FT. MEADE



0 019 056 072 7